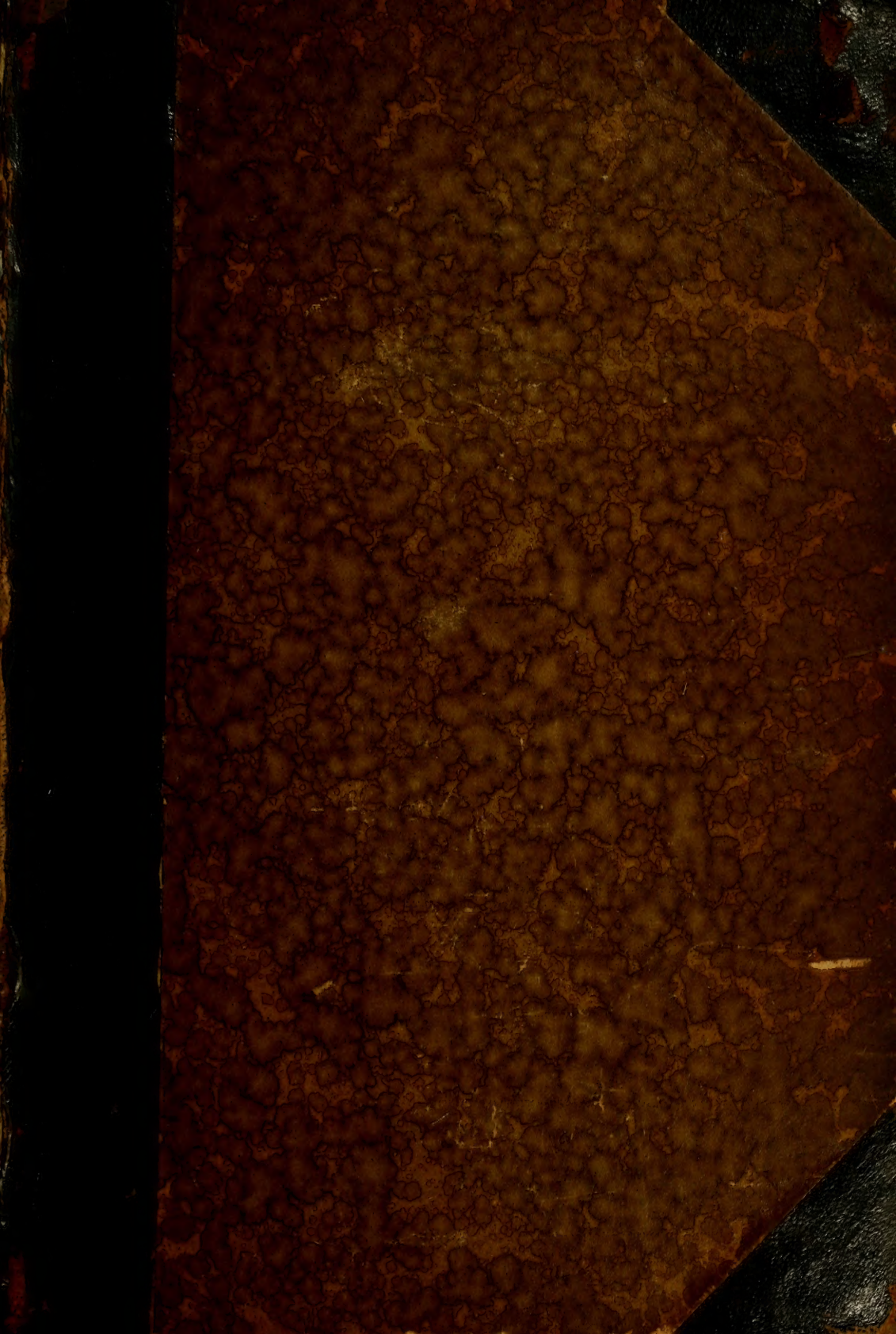
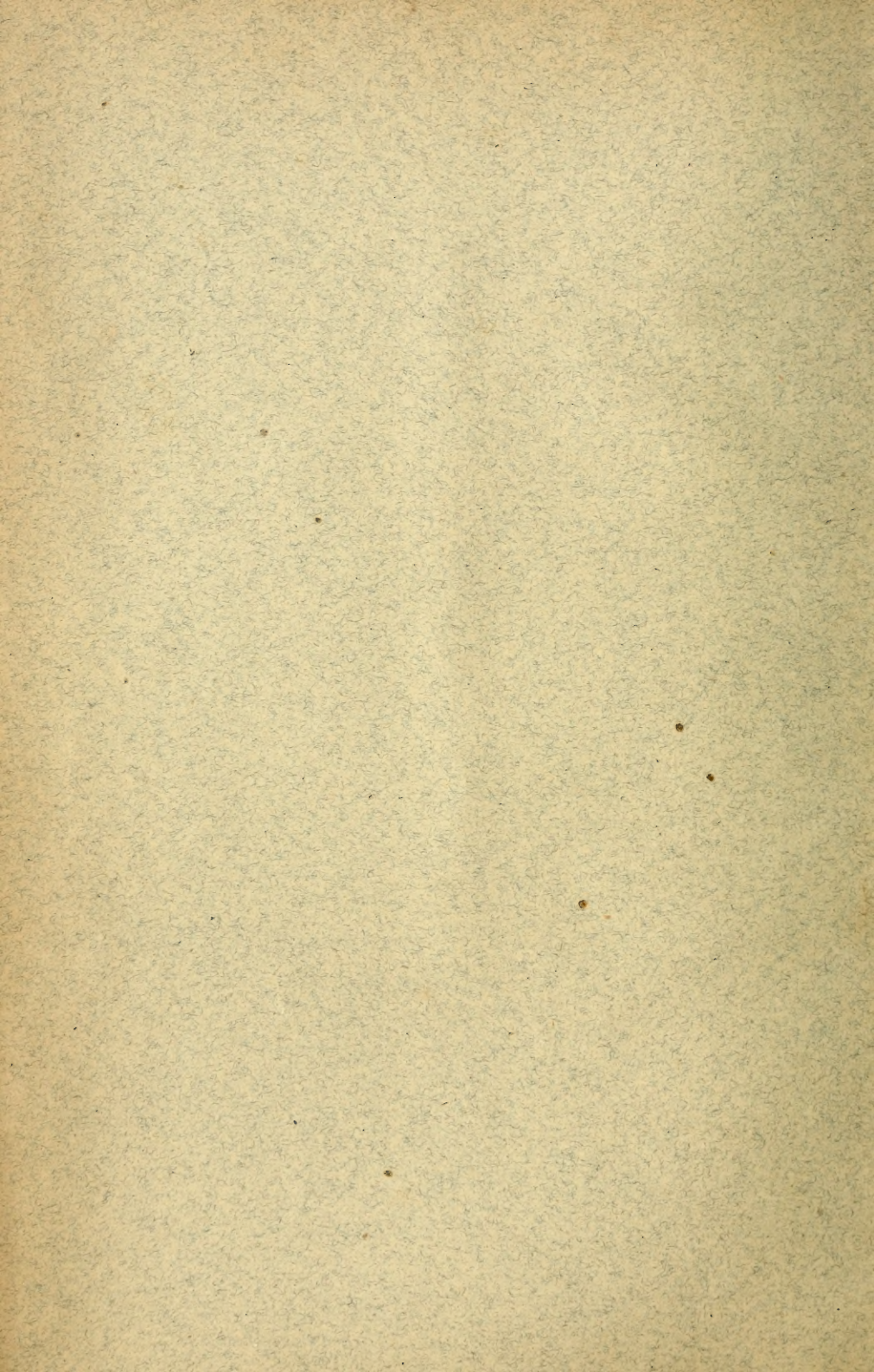




D. S. Kellicott:

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No. 1.

The Nummulites of North America.

IN the last number of the *Proceedings* of the Academy of Natural Sciences of Philadelphia, is an article by Mr. Angelo Heilprin, on the Nummulites of Florida, upon which this article is based. The nummulites, as the reader will doubtless know, are a genus of the Foraminifera which grow in a spiral, the outer whorls more or less completely enveloping the inner ones. The interior of the shell is divided up into successive chambers by septa. Although the fossil nummulites are very abundant and very large in some parts of the world, none have been positively identified in North American strata. A species has been described as occurring in Florida under the name *N. floridanus*, but, from the imperfect accounts published, it seems probable that this form should be placed among the *Orbiculina*. In examining the rock in which the so-called nummulite was said to be found, no trace of its existence was discovered, but another form, *Aperculina rotella*, was quite abundant. There were, indeed, disciform bodies found, measuring about a quarter of an inch in diameter, which might be taken as a form of foraminiferal test, but they were in such an imperfect state of preservation that nothing definite could be made out of them.

The late researches of the author of the paper referred to, have conclusively proved the existence of nummulites in Florida. The rock in which they were found was obtained from the western shore of the peninsula of Florida, a yellowish-white, friable limestone, in

the vicinity of Cheesowiska River, Hernando County, about four miles from the coast line. In some places they are so abundant as to constitute masses of a true nummulitic rock.

All the specimens appear to belong to the same species, *Nummulina Wilcoxi*, n. sp. It is described as follows: Test regularly rounded, tumid, measuring in the largest specimens $\frac{1}{2}$ of an inch in diameter; external surface distinctly marked by the arcuate and wavy outlines of the septal prolongations, volutions about 5, completely enveloping, septa close set, about 35-45 in the last whorl, and well flexed; initial chamber distinct. In the illustration, the first figure shows the form of natural size, the second is an enlarged view.



Nummulina Wilcoxi.

There is still an interesting geological question to be decided concerning the age of the deposit in which the nummulites are found. That they are not in their original position is proved by their association with land and fresh water shells of a much later period than the age of nummulites, which are seldom, if ever, found later than the eocene or oligocene deposits. It is probable that the rock from which they were originally derived, will be found along the border of the gulf, possibly submerged.

Crystals in Plants.

If we strip off the outer coverings of the bulb of an onion and examine it with a microscope, it will be found that the cells contain many crystalline masses, made up of prismatic crystals, radiating from centres. These are clearly recognized when polarized light is used, for they will shine out bright when the nicols are crossed so as to give a dark field. Besides the onion, many plants have crystals in some parts of their structure, and they form very good subjects for study. Comparatively, little is known about the crystals of plants. Most of them consist of calcium oxalate, but other compounds are also found; just what part they play in the economy of the plant, is not known. To the microscopist, they afford objects of beauty, while they are sometimes of great service in assisting him to detect adulterations or mixtures of vegetable drugs.

Crystals of plants are classified in four groups: raphides, sphæraphides, long prisms and short prisms.

Raphides are long, slender, needle-like crystals, tapering at both ends, occurring singly or in bundles within the cells. They are usually composed of calcium oxalate, rarely of calcium phosphate. Raphides are abundant in many plants, especially among the Onagraceæ. They can be well seen in the leaves of fuchsia, and in asparagus, hyacinths, hydrargia, etc.

Sphæraphides are stellate groups of crystals, or globular crystalline aggregations. They are very abundant in the common rhubarb, viburnum, and in many of the Urticaceæ.

The dried rhubarb-root, used in pharmacy, will show them in profusion. Large groups are also found in the pulp of a ripe pear.

The long crystal prisms do not, like the raphides, occur in bundles, but singly, or two or more joined together at different angles, as in the onion. These are found in the bulb-scales of the onion, in sweet orris, in the ovary-

coat of the thistle, and in many other plants.

Short prismatic crystals are very abundant in the vegetable kingdom. These crystals may be prismatic in shape, or they may be merely cubical and octahedral. They abound in the pericarp of geranium, in the leaves of tradescantia, the common "inch-plant" or "wandering Jew," and in bigonia.

Plant-crystals are most frequently calcium oxalate, but calcium carbonate is said to be frequently found, and occasionally the sulphate, tartrate and malate of the same base, besides other salts.

Dr. Aser Poli, in a short article recently published,* asserts that there are no crystals of carbonate and sulphate of lime to be found in plants.

All crystals insoluble in acetic acid but soluble in mineral acids, (muriatic, nitric, sulphuric acids, etc.,) consist of calcium oxalate.

Crystals can be best studied in thin sections of those parts of the plants in which they are most abundant. In many cases they can be separated from the cells by washing a freshly-cut surface of a leaf, for example, in water, on the slide. This is frequently a very expeditious method of obtaining raphides. Another method of studying them, is to boil the leaf, or other part, in caustic potash, which destroys the soft parts of the plant and the coloring matter, exposing the crystals to view. The tissues may be stained after treatment with the potash solution and thorough washing.

A New 1-6 Inch Objective.

BY A. Y. MOORE, M.D.

A few months ago the Spencers constructed a homogeneous immersion $\frac{1}{16}$ inch objective of 125° balsam angle which was the best they had ever made and it certainly was a lens deserving of praise.

* *Journal Royal Microscopical Society*, Ser. 2, Vol. 11., p. 598.

Some time after the completion of the formula of this $\frac{1}{10}$, they were requested by me to make a new homogeneous $\frac{1}{8}$ in., which resolving power should be held paramount, and which should excel both the new $\frac{1}{10}$, and their $\frac{1}{8}$ of 120° b. a. The new $\frac{1}{8}$ would, of course, necessitate a new formula, and that of the $\frac{1}{10}$ was modified and adapted to the power of the $\frac{1}{8}$.

The Spencers assured me that this $\frac{1}{8}$ was positively the best objective they had ever looked through, and as a few words concerning it may be of interest, I will describe it.

The mounting is similar to that of the old $\frac{1}{8}$, of red brass and gracefully proportioned. By means of a graduated screw collar, a rectilinear motion is given to the back systems sufficient to bring about the proper correction for use with water, glycerine, or homogeneous fluid, or for a considerable length of draw tube. The magnifying power—measured at ten inches from the front lens—is, at the open point, 63, at the closed point 70 diameters. The angular aperture is given as 130° in balsam, and is constant throughout the entire range of the collar—if the same fluid be used. The residual color is somewhat greater than is usually seen in Spencer's objective; but still it is well corrected, and the field is flat.

This objective is remarkably sensitive as regards spherical aberration, and a slight change in length of body, or so called homogeneous fluid, makes itself known by a disturbance of the spherical correction.

The special quality desired—that of resolution—is not disappointing. The diatoms of Möller's balsam plate are easily resolved—No. 16 in dots by central light, and No. 18 in dots by oblique light—lamplight.

Accepting the orthodox view, it would seem unreasonable to expect such an objective to do well on histological work, but, on the contrary, it works beautifully. The circulation of blood in a frog's foot is beautifully shown with this glass—using it, of course, as a water-immersion, without covering

glass, and with powers as high as 1,000 diameters. The white corpuscles can be seen much better than with any narrow angled glass with which I am acquainted. I regard a frog's foot as a very good histological test. The circulation of blood and contraction of the muscles in the leg of *Ranatra fusca*, are also beautifully shown by this one-sixth.

It seems to me that it is a great mistake to put a wide-angled objective—even though it be homogeneous immersion—in a non-adjustable mount, for it so frequently happens that the length of body or density of the immersion fluid varies from that for which the objective was originally corrected, and in such cases the best performance of the objective is lost. Not only should it be adjustable, but it should have sufficient range of adjustment to correct for water, as water is far better suited to work over temporary slides than either glycerine or homogeneous fluid.

Pond Life in Winter.

Mr. E. Wade Wilton, in a short article in the *Journal* of the Postal Microscopical Society, gives some useful information about the microscopic life to be found in ponds in winter. Contrary to the prevalent idea, a great number of beautiful and interesting forms of life can be found in the middle of winter, under ice a foot thick or more. One of our richest collections of *Volvox* was made in a pond covered with ice, through which we had cut a hole with an axe, large enough to admit a small collecting net, or bottle. The water teemed with *Volvox*, and near the bottom *Cyclops* and *Daphnia* were found in great abundance.

Infusoria are to be found in great numbers under the same conditions. Mr. Wade-Wilton, in the article referred to, states the conditions under which the infusoria develop in greatest abundance, as follows:—

“Those microscopists who keep an aquarium, and are in the habit of

searching in it for living microscopic animals, must have noticed that when there is a superabundance of decaying vegetable matter in the aquarium—that is, when there is only so much decay taking place in the water as will not interfere with the health of the higher animals inhabiting it—the microscopic animals are found in the greatest abundance; The Polyzoa and Tubular Rotifera, especially, are found in the best condition under these circumstances.

"The winds of October and November drive a large quantity of dead leaves and other lifeless vegetable matter into the ponds, which, decaying, form a black, offensive ooze. . . . In this ooze the prevailing forms of animal life will probably be."

The same writer also states that *Chara* and *Nitella* may also be obtained in the depth of winter. This is not in accordance with our experience, but we do not venture to contradict a statement made so directly. If any of our readers do find these plants living in cold weather, we would be pleased to learn of it.

The Podura Scale.

BY CHARLES STODDER.

The excellent article on the Podura scale in the DECEMBER JOURNAL deserves the attention of microscopists, and should induce them to study this famous test. It is true it is not a test of resolution, like finely striated diatoms, or Nobert's and Roger's rulings, but it is a test, and a good one, of definition. Richard Beck's figure of the scales of *Lepidocyrtus curvicolis* is the earliest correct one I know of. The late Prof. J. Bacon told me that he had seen the same appearance (with Spencer's objectives) long before Beck published his article. Dr. Pigott was the first, I believe, to question the accuracy of Beck's observations, and his paper on the subject caused quite a discussion among London microscopists. I had accepted Beck's figures as correct, and they are accurately correct as to appearance by

central light. I tried Pigott's illumination by oblique light, but could never obtain confirmation of his theory of a beaded structure. There is, to be sure, an appearance of beads, as there is in almost every object consisting of minute particles of transparent matter.

A few months ago I received a letter from an esteemed correspondent, in which he referred to the "spines" of *Lepidocyrtus* scale. I have fine specimens of it, and when I sat down to my tube to refresh my memory of it, I obtained the exclamation marks perfectly according to the usual representation. Then I used oblique light with varied angles of incidence; at the best illumination the so-called "spines" totally disappeared. It is my belief that "spines" projecting from a surface, as these have been said to project, cannot be made to disappear by changing the direction of the illumination. In the place of the exclamation marks, there were longitudinal lines, or ridges, with more or less unequal expansions, producing the appearance of spines or exclamation marks. In short, Dr. Woodward's theory, published some years ago, is the correct one of the structure of the Podura scale. The spines have no tangible existence. Your paper has a more important bearing on microscopy, animal and vegetable histology, than the study of the insect scale would indicate. I refer to the fact which you mention; that different instruments give different images. This I was aware of, but it is the first time I have seen it mentioned, and in this case it is conclusive, for you mention several observers all using the same instruments at the same time, under the same conditions.

Is it not the same as with *Podura*, that all complex structures will present different appearances with different objectives and eye-pieces? Eminent observers who have used one set of lenses for years know only what they see with them, and it is but a fair inference that much of their work "has got to be done again."

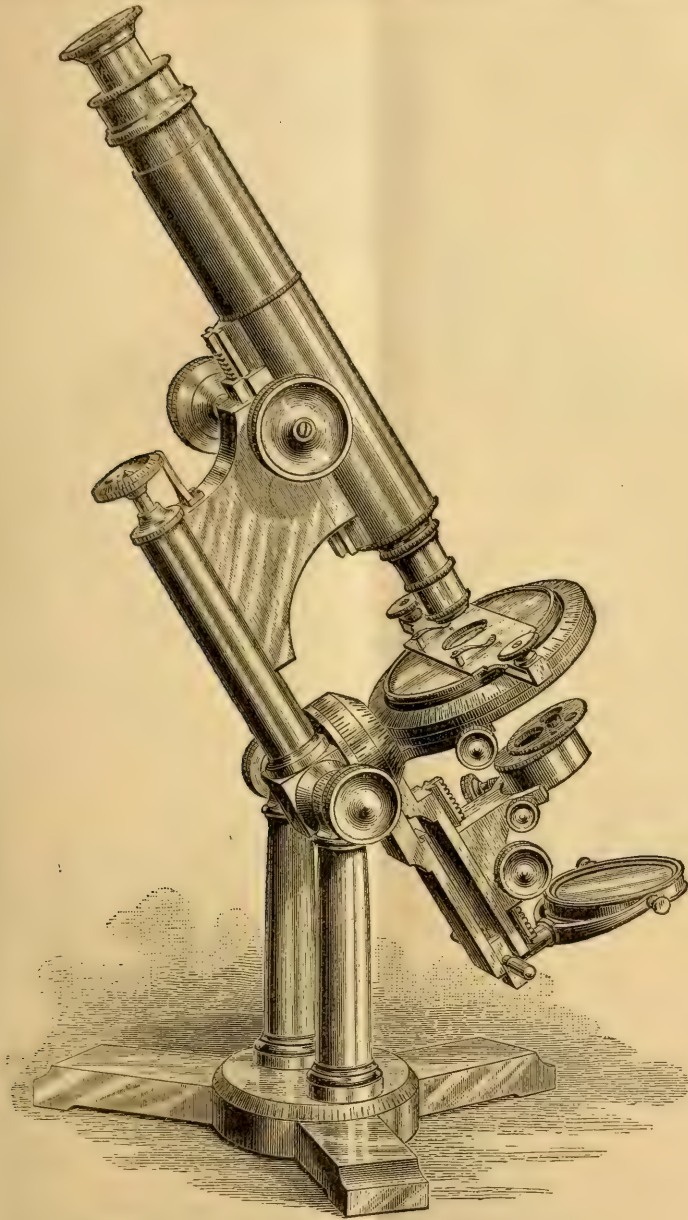


FIG. 1.—BAUSCH & LOMB'S "PROFESSIONAL" MICROSCOPE.

New Microscopes.

We promised, some time ago, to give an illustration of the new microscope made by Messrs. Bausch &

Lomb. We do so this month. The stand is represented in Fig. 1. It needs no description, but the excellence of the wood-cut deserves especial mention. The stand was exhibited last

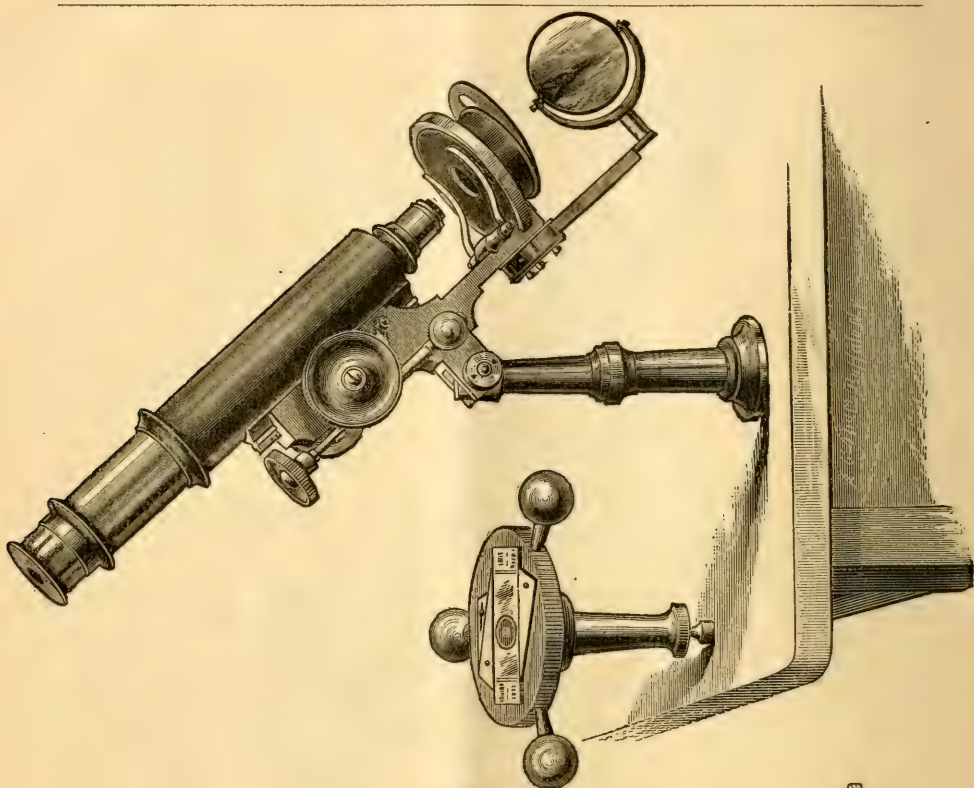


FIG. 3.—GRIFFITH-CLUB MICROSCOPE.

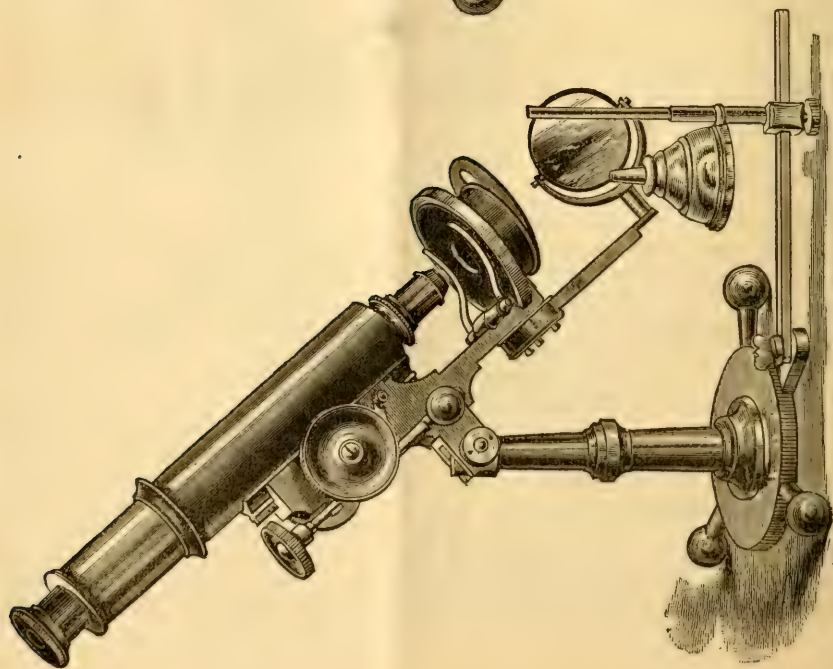


FIG. 2.—GRIFFITH-CLUB MICROSCOPE.

summer at Montreal, and, we believe, received universal commendation from microscopists.

We also represent the Griffith Club Microscope in its latest and most improved form. In Fig. 2 the stand is shown standing upon its base with a lamp attachment, so that the microscope and lamp can be moved about without changing the illumination. In Fig. 3 the stand is screwed down to the work-table, while the part which constituted the base in the preceding figure is now shown converted into a turn-table, and a very good turn-table it makes. Fig. 4 shows the stand packed in its case. Mr. Griffith has expended a great deal of ingenuity, time, and money in perfecting this stand, and he now offers it as a compact microscope for travelling, but also as a stand suitable for all purposes, to meet all the requirements of the microscopist of whatever nature they may be.

Natural History of the Oyster.*

After speaking of the great system in physiology known as the vegetal, the professor took up the ingestion, respiration and circulation of the oyster, which he illustrated with the help of the blackboard and diagrams. In

* Abstract of an Address delivered by Prof. Samuel Lockwood, before the New York Microscopical Society, Dec. 15, 1882.

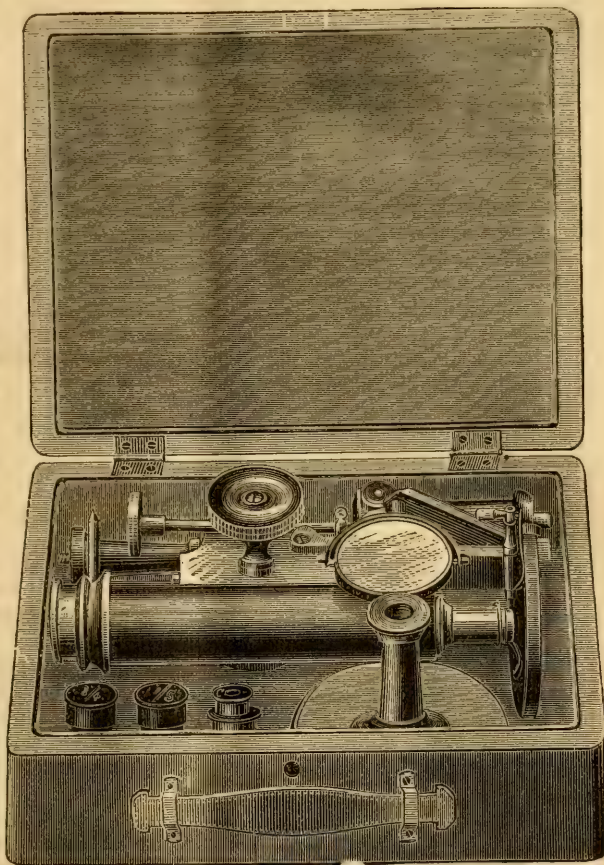


FIG. 4.—GRIFFITH-CLUB MICROSCOPE.

regard to the ingestive system, he showed the course which the water took in conveying food to the mouth of the oyster, and described the action of the lips of the oyster in eliminating the food from the water. The position of the stomach was then shown, with the convoluted intestines, and where the fœces were discharged at a spot where the effete water that had been taken to the mouth returned in a stream, thus carrying the fœcal refuse out of the shells. Further on he showed the peculiar internal structure of the intestines, by which the greatest surface was made available for the

absorption of food into the general system.

In regard to the respiration, he showed how the water entered the gills, and by a series of innumerable millions of little lashes in action, like oars, carried the water through the minutest part of the gills, eliminating the oxygen from the contained air. In respect to the circulation, he showed the heart in pulsation, composed of the ventricle and auricle, the latter receiving the aerated blood from the gills, giving the same to the ventricle, which by two aortas distributed the blood through the entire surface of the animal. He spoke of the oyster as having some capacity for education, in that it can adjust itself to many new environments; and then went on to describe the building up the oyster's house,—its shells. He told how the shells were formed, and how the age of an oyster can be told by the layers of the shells, by the hinge-lines, and by the position of the adductor muscle. He then described the companions of the oyster and their habits; detailing their efforts in gathering food for the mollusc; and also the enemies of the oyster, such as the drum fish, that grinds them up, destroying millions of them in a night; of the drill, that bores a hole through the shell and then sucks out the life and body, unless the oyster defeats the attack by plugging up the hole. The sea-star and the conch were added to the list of enemies, each one's operations being minutely described.

Carbolic Acid in Mounting.

BY WM. J. POW.

In our last number there appeared an article on the subject of mounting without pressure, taken from an English periodical. In that article the advantages of the method described were well set forth, and no reader can fail to appreciate the value of any process which enables us to remove the air from an object without drying it,

and causing it to become hard, and readily injured by handling. The method there described is an excellent one when the insect to be mounted is opaque, and of considerable size. The use of the soda-solution is to make the opaque portions transparent, and it softens the hard parts.

There are many insects which do not require the use of the solution of soda, and even among those that do require it to render them quite transparent, may still make beautiful objects when mounted in balsam by the method to be described in this article. For ourselves, we do not like to use alcohol in mounting insects, because it hardens the parts, making them stiff, and not as readily arranged as may be desired. In the case of vegetable tissues, it is sometimes objectionable for the same reason. An excellent substitute for alcohol, and one that can be almost universally used in its stead in mounting, is carbolic acid. Contrary to the general opinion, carbolic acid is not an acid, and the name is misleading. It has no acid properties whatever. Chemically speaking it is an alcohol, belonging to a series of alcohols quite different in composition from common ethyl alcohol, which we use, and from wood spirit, which is closely related to common alcohol. But carbolic acid is, nevertheless, a true alcohol, and for this reason it can be frequently substituted, for ethyl alcohol is microscopical work. But what advantages has it over the latter? One great advantage is found in the readiness with which it penetrates a specimen, and mixes with the fluids used in mounting, such as water, glycerine and Canada balsam. Another is, that it does not harden tissues and make them stiff. For this reason insects, or parts of insects, can be preserved indefinitely in carbolic acid, in a fit condition to be mounted at any time. The more delicate parts are made quite transparent by long soaking in the solution; but this is no detriment to them.

It is our custom, when going out in

the country, either for a walk, or to collect objects for the microscope, to carry a small wide-mouthed bottle along, about half full of carbolic acid. Into this we immediately drop any minute insects we may find. The acid kills them instantly, and in most cases their legs are not found doubled beneath them, as in all other methods of killing with which we are acquainted.

The acid used for this purpose, or for mounting, should be the strongest solution,—having just enough water in it to keep it fluid at ordinary temperatures. To use it for mounting, it is only necessary to drop the specimen into the acid, and in a few moments transfer it to the prepared cell containing the medium in which it is to be mounted. Suppose it is desired to mount a mosquito, or a plant-louse, or any minute insect which requires no preliminary treatment, drop the insect into the acid, and in a few minutes it will be seen that the fluid has thoroughly penetrated the body. Then it is quite immaterial whether the specimen is to be mounted in water, or glycerine, or balsam, for carbolic acid will mix as readily with one as with the other. Fill the cell with the medium to be used; place the specimen on a clean slide, and take up the excess of fluid with blotting-paper; then transfer it to the cell and arrange the parts with needles, when the cover-glass can be applied.

When deep cells are required for balsam mounts, we are accustomed to using brass curtain-rings, cemented to the slide with shellac, or with hard balsam. Shellac is preferable if asphalt varnish is to be used to finish the mounts. After the cover is applied, the slide may be gently heated until the outside balsam is hard enough to keep the cover in place. Then the excess of balsam can be cleaned off, and a ring of shellac applied to protect the balsam, when the brass ring may be concealed by any finishing varnish. The same cells may be used for glycerine or water mounts.

Another way to make deep cells for balsam is as follows: Build up a cell of adequate depth for the object, by successive layers of benzole-balsam, and let this harden thoroughly. Then fill it with soft balsam, and mount as before. As a precaution against injury to the cell, three pieces of thin glass may be placed within it to support the cover. Such a cell can be finished with damar varnish, and makes a very attractive mount.

When insects require any preliminary treatment to make them transparent, the soda solution should be thoroughly removed by washing with water; after which the specimens should be taken out one by one, the superfluous water removed with blotting-paper, and then thrown into the carbolic acid.

This method of mounting is the simplest and best one we know of. If the reader chooses to experiment with it, let him take the head and proboscis of a blow-fly, or any part of an insect that may be available, and, without any preliminary treatment, place it in carbolic acid, and mount it in balsam without pressure. A single trial of this kind will convince him of the ease with which excellent mounts can be made; and every one who tries it will be a convert to the new method of mounting without pressure.

We have used carbolic acid instead of alcohol in mounting stained sections of wood, with excellent results, and it is much cheaper than alcohol.

Starch.

The structure of starch granules has never been very fully made out, although many observers have studied the subject, and various views have been put forward by different authors. Among them the conclusions of Nägeli seem to have received most general acceptance; although many have never regarded them as entirely satisfactory. There is great difficulty in following the process of growth of starch granules. We will not attempt

to even briefly consider the relations between starch and chlorophyll, as this part of the subject is still enveloped in uncertainty. Some observers consider that starch is the direct product of the action of light upon chlorophyll, while others deny that chlorophyll is necessary for the production of starch. The granules originate in vacuoles in the protoplasm of plant-cells, and seem to be secreted from the interior surface of the vacuoles, precisely as the cell-wall is deposited by the primordial utricle.

Before considering this process more particularly, it may be well to allude to the structure of the perfect granules. We are accustomed to saying that starch is colored blue by iodine, but the granule is composed of two substances, only one of which, known as granulose, is colored blue by the iodine; the other component, cellulose, being quite inert. The granulose is soluble in saliva, and in dilute chromic acid. By treating the granules with either of these re-agents the soluble portion can be removed, leaving the cellulose, and showing the concentric markings of the granules very distinctly.

The hilum, or dark spot, to be seen on almost all starch grains, was formerly regarded as the point of attachment of the granules to the cell-wall. It cannot be so considered at present. It is merely the point at which growth begun. The markings are usually more or less eccentric, owing to the more rapid growth of the granule away from the protoplasm in which one end is imbedded.

The eccentric markings have been supposed to indicate successive folds in a membrane covering the granules, but at the present time the views of either Nägeli or Strasburger are regarded as more probable. The former considers that the granules grow by a process of internal growth, the new material being added within, the outer portions being the older. In some way the granules become differentiated into successive, enveloping,

alternately firm and watery layers, which cause the peculiar markings seen on the surface. As the granules increase in size the outer portions become stretched or distended by the accumulation of starchy matter within. The evidence to support this view is mainly founded upon observation of the distension and destruction of the granules by means of heat and chemicals. In warm water the successive layers can be observed to separate slightly, perhaps owing to the expulsion of air from between them; and this affords positive evidence that the markings do not indicate folds of a membrane. In boiling water the cells swell very much, and some of them burst, discharging a flocculent substance from their interior. Rather strong sulphuric acid acts quite rapidly upon the inner portions of the granules, at first causing them to expand and distend the outer layers, but afterward the entire granule expands into a very large, smooth sac.

Strasburger's conclusions differ very much from those of Nägeli. He regards the granules as composed of concentric layers successively deposited.

According to this observer, if Nägeli's view of the micellar structure of organic bodies were correct, the disintegration of a granule would not affect the action of the particles upon polarized light. The parts would still act upon the light just as would the parts of a double refracting crystal.

Strasburger considers that starch grains, and organic structures which act upon polarized light, do so by virtue of their organization as a whole — of the arrangement of the ultimate molecules composing them. In this case, the moment the structure is destroyed the polarizing action would be lost. He regards the molecules of all organic bodies as linked together by chemical attraction in a reticulate manner, probably by what are known to chemists as multivalent atoms. Protoplasm differs from other organized matter because the molecules compos-

ing it are constantly changing their grouping, and the result of these changes is manifested in the phenomena of life.

The same observer explains the production of starch, cell-walls, etc., by an ingenious hypothesis founded upon his observations. Wherever a membrane is to be formed about a mass of protoplasm, proteid bodies, which he designates microsomata, arrange themselves in abundance in a layer, and from these the membrane is formed. The protoplasm seems to be first converted into proteids, and these in turn disappear while cellulose takes their place. In this way, the layers of starch granules are formed by the conversion of proteid substance derived from the protoplasm of the starch-bearing cell into starch.

Volvox Globator.

Mr. N. E. Brown, of Kew, has communicated the following note to an English Journal:—

"This interesting microscopic plant is, according to the experience of myself and some other microscopists, a most difficult one to keep for any length of time, but as I have at length found out a way to keep it, others may be glad to know the plan. For several years I have collected *Volvox*, and placed it in large glass and earthenware jars, small bottles, open dishes, and other vessels, and exposed it to full sun, or kept it in partial or entire shade, supplied it with rain, pond, and spring water, in turn, but always with the result that after a short time it disappeared. However, on October 7, 1878, I collected from a pond on Earlwood Common a small quantity, probably not more than 100 individuals, in a 4-oz. bottle, having a mouth three-quarters of an inch in diameter; this I placed on a shelf at the side of an outhouse, which had no guttering, so that the rain in running off the roof could drip into the bottle; here it has remained until now, nearly thirteen months, and instead of the

few original specimens they are now abundant. I have never changed or replenished the water, only that which dripped naturally from the roof into the bottle has been added to the original stock, and during the abundant rains we have had this year the bottle often overflowed. I have several times taken a portion of the water containing *Volvox* to place in my several jars and dishes standing in various parts of the garden, but these always died in a short time, whilst those left in the small bottle, treated as above, have remained in perfect health, and multiplied. The position in which the bottle is placed faces the north, so that it only gets the sun in the early morning of the summer months. It may be worth recording that, during the severe weather of last winter, the water containing *Volvox* was several times frozen into a solid mass of ice, but apparently without injuring the *Volvox*. Although I have carefully looked several times every month since I have had the *Volvox*, I have never seen any indication of the antheridia and oogonia, so well figured and described in Cohn's *Beitrag*, i., Part. III. p. 93, t. 3. Has any one observed them in this country? Cohn says the autumn is the time when these are developed."

Volvox can be preserved for weeks in-doors in a small bottle placed in a cool place near a window, with a spray of *Nitella* or *Anacharis*.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 32 Hawley Street, Boston, Mass.

CONTRIBUTIONS, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

THE index of Vol. III. was published last month and sent with the December number. A glance through

the index will show that there is a considerable amount of information in that volume, in a condensed and readily available form.

TO SUBSCRIBERS. — This number of the JOURNAL is sent to all subscribers of 1882. The post-office regulations allow subscribers who have paid up to date, and who wish to discontinue taking their papers, to return them to the publishers free of postage, in the original wrappers. This saves the trouble of writing a letter, and is the simplest and surest way of stopping a subscription.

On the other hand, whoever takes papers from the post-office becomes legally responsible for the price of subscription. Consequently, we shall consider that those former subscribers who do not return this number, desire their subscriptions to continue through the year.

Many of our readers are affected with the too common habit of procrastination, which leads them to defer paying their subscriptions until late in the year. We can assure them, confidentially, that the habit is a very bad one, and should be corrected. We have to be a little indulgent, however, when we reflect that their intentions are good; but we take occasion to remind them about certain annually recurring good resolutions, which were adopted for the ninth time, only a few weeks ago.

Occasionally our confidence is grossly abused, but not often. Last month, for example, after the December number was out, a subscriber wrote on a postal-card: "Stop my Journal." It was a concise order, and we understood it. But that subscriber has not paid his dollar for 1882 yet! Of course we do not care for the few paltry dollars we lose in this way, but it is the immorality of the thing that grieves us. Just think of the wickedness of such men! Verily, money is "the root of all evil."

Sometimes we feel that a little

evilness would be good for us, but our better nature always prevails, and we never get any.

Since the above was written the JOURNAL has passed into the hands of its new publishers. It is just possible that they also would like subscribers to pay promptly. We are glad of the opportunity to speak a good word for them thus early in the year.

CHANGE OF MANAGEMENT. — The editor takes pleasure in announcing to his subscribers the change in the business management of the JOURNAL, which, although effected since the December number was issued, has long been contemplated. For various reasons it is believed that the change will commend itself to the readers. It relieves the editor of a great amount of work of a purely clerical nature, and thus enables him to employ his time in a more congenial, as well as a more profitable manner, while it places the JOURNAL in the hands of those whose experience as publishers insures careful management, and attention to the details of the business of any periodical in which they are interested.

The JOURNAL will hereafter be published by the well-known publishers, S. E. Cassino & Co., of Boston, to whom all letters on business, — subscriptions, orders for advertising, etc., — should be addressed.

The address of the editor will remain as heretofore.

EDITORIAL PERPLEXITIES. — One of the greatest difficulties an editor has to contend with is the different estimates of published articles by readers of different tastes. It is impossible to please all.

To show the great difference in tastes, we have only to refer to a very recent occurrence. A gentleman came into the office, and incidentally, and in a very friendly way, referred to the "last number" as containing very little matter that would be generally

read. Within half an hour another gentleman came in and offered his congratulations for the unusual excellence of the "last number."

Perhaps nobody can tell better than an editor the real worth of the articles he publishes; but it is a very different matter to know how those articles will be valued by the readers of his paper.

There is a very large class of readers who seem to regard this periodical as a medium of instruction in elementary microscopical manipulations, such as are to be found in every book treating of the microscope. In the first volume we did give a number of articles on the preparation and mounting of objects. Those articles covered the ground well, and we have not deemed it necessary to repeat the instructions in detail. But, on the other hand, all new suggestions, all new processes and methods which have since been proposed, and which have seemed practical and valuable, have been duly noticed in these columns. We do not pretend that this JOURNAL can take the place of a text-book; but that it supplements the latter by giving new processes, and a summary of new observations and discoveries.

We have frequently been urged to enlarge the JOURNAL, and increase the price of subscription. We have not deemed it good policy to do so; but we are pleased to say that the present publishers have already expressed a desire to enlarge it; and we have no doubt that if they receive liberal support and encouragement from subscribers during the present year, they will do so.

THE CAUSE OF TUBERCULAR DISEASE.—Ever since the announcement, by Koch, of the discovery of a bacillus as the cause of tuberculosis, the medical journals have been publishing articles about the *Bacillus tuberculosis*, and the pathology of the disease. It is astonishing to see how many physicians have studied this subject so thoroughly that they have been ready

to prepare articles upon it for publication, within such a short time.

We wish to call the attention of our medical readers to the fact that the discoveries announced by Dr. Koch come from a man whose work in connection with the organisms of contagious diseases has made him a recognized authority upon the subject,—a man whose observations and conclusions are not to be lightly thrown aside.

No man can hope to obtain accurate results in such investigations, until he has passed through a certain amount of preliminary training. So, it does not in the least affect the question to learn that Dr. So and So has found the *Bacillus*, or that another doctor has not found it, unless those gentlemen have already done a sufficient amount of work of the same kind to enable them to speak as competent observers. Now we do not wish any one to infer that we regard Dr. Koch's observations as conclusive. Far from it. But we do believe that his evidence carries far greater weight than the evidence of many observers who have attempted to criticise and refute it. We wish to caution our readers against accepting too readily the observations of those not trained in this work. The literature treating of the relations of bacteria to diseases is replete with errors of observation, mostly due to the superficial character of the work done. No one who has not been practically engaged in the study of bacterial organisms, or who is not at least familiar with the details of the work done by others, can have any adequate conception of the difficulties to be overcome in carrying any course of experimenting to a satisfactory issue. Indeed, it would seem that some observers never succeed in this work. If we could only weed out the careless ones, and suppress from publication all erroneous results which originate in careless work, progress would be much more rapid.

Dr. Schmidt, of New Orleans, a gentleman whose name is familiar to

our readers for his meritorious work in combating the germ theory of disease, has announced that he finds Koch's *Bacillus tuberculosis* to be crystals of a fatty acid! We are utterly unable to conceive how such observers as Koch, and many others who have repeated his experiments, could make such a serious blunder, as indicated by Dr. Schmidt. It is simply incredible. We have ourselves seen the *Bacillus*, and although the idea of its possibly being crystals of fat had not then been presented to our mind, we are reasonably confident that such was not the case.

Whether the results arrived at by Koch are sustained by future observations or not, the question of the contagiousness of tubercular disease may be regarded as almost an established fact. The evidence in favor of this view has become very strong since attention has been drawn to the subject by the announcement of the discovery of the bacillus. If consumption be a contagious disease, few will be found to doubt that it is caused by some living organism, whether a bacillus or a micrococcus is still, we think, uncertain.

Investigations on this subject deserve encouragement on every hand. In no way can greater benefit be conferred upon the race, than by the discovery of the bacterial origin of tubercular disease. For we may assert with perfect confidence, that just as surely as it is found that tuberculosis is caused by living fungoid germs, so surely will the disease become amenable to medical treatment, and the mortality from it be diminished. Such a conclusion is justified by past experience with other diseases of a similar origin.

ROTIFERA WITHOUT ROTARY ORGANS. — Prof. Joseph Leidy described a number of rotifera without rotary organs, in a paper presented to the Philadelphia Academy of Sciences, which is printed in the *Proceedings*, and illustrated with a plate, showing

different parts of *Acyclus inquietus*, Leidy, *n. s.p.*, found in the Schuylkill River, and a figure of *Dictyophora vorax*, which Prof. Leidy regards as probably identical with *Cupelopagis bucinedax*, described by Prof. Forbes on page 102 of Vol. III. of this JOURNAL.

THE AMERICAN POSTAL MICROSCOPICAL CLUB. — The operations of this club have been greatly interfered with by a few members "who persistently failed to forward the boxes they received." This is well known to many members of the club, and it will be pleasing to them to learn that those members will be dropped.

The operations of the club will soon be resumed, and we trust there will be a careful revision of the list of members. It is our intention, hereafter, to notice in these columns the contents of the boxes as they come to us. There are some members who, while quite willing to avail themselves of the advantages of the club, seem not to regard it as any part of their obligations as members to contribute to the general interest and value of the boxes. Such persons, because they must put in a slide in at least one box in the course of a year, select some miserable preparation of some common object, of no value, and put it in, and consider their duty done. We think every member of the club should feel morally bound to put in an instructive preparation, and to write a few words descriptive of it, indicating its special points of interest. To do this does not require profound knowledge of any branch of study. We take it that original observations are only expected from a very few members of the club. The great purpose of the club is to contribute to a general knowledge of microscopic objects. If a member puts in a section of a plant-stem, or of a leaf, any one well informed in histological botany will immediately discover its peculiar characteristics. But how about those whose studies have been conducted in other

directions, — what do they know about it? We do not ask for elegant mounts in every case, but we do call for objects that shall be instructive and worthy of examination, and for a few words of explanation, accompanied with illustrative drawings when desirable and practicable. We hope to see the Postal Club increase in importance every year, and we shall give it every encouragement within our power. The notices we shall give will enable contributors of slides to learn where they are as they pass through our circuit.

Applications for membership should be addressed to Dr. R. H. Ward, Troy, N. Y.

A NEW SCIENCE PUBLICATION. — A new weekly scientific journal has been established in this country, which deserves the support not only of every teacher and student of science, but also of the intelligent reading public; for at the present time no person can occupy an enviable position in cultured society, without some knowledge of the progress of scientific thought and discovery.

The new weekly is *Science*, published by the "Science Company," incorporated under the laws of Massachusetts, with a capital of \$50,000. The principal financial support of the enterprise is understood to come from Prof. A. G. Bell. It is announced that "the first year's expenses of *Science* will probably exceed \$40,000." This announcement, while it indicates the spirit in which the scheme has been fostered, and is a satisfactory guarantee of the final success of the enterprise, likewise indicates that there may be more scientific talent than business acumen in the company. This opinion is also borne out by the announcement that no specimen copies will be distributed free. We are assured that a few months of experience in publishing a newspaper, will be sufficient to show that a thoroughly liberal policy, in this respect, is the only successful one. True, a certain number of persons throughout the

country will subscribe for the paper on the strength of the announcements made by the press and in the circulars; but the main support of such a paper must inevitably come from a much larger number, who cannot afford to pay \$5 for a paper until they are assured, by having seen it, that it meets their wants, or who, at least, will not do so.

That this is true with regard to *Science*, we know, because many persons have already inquired of us concerning it, and almost without exception they have declined to subscribe for it until they see a copy. The reasons they give are, we must confess, good ones. We refer to the business affairs thus at length, and thus freely, because we desire to see the immediate success of *Science*. Its ultimate success is assured, — its immediate success can only be assured by a liberal policy at first. In our opinion it is not necessary to sink even a thousand dollars in this enterprise during its first year, if the business is properly managed; but if the policy announced is persevered in, we would not be surprised at a loss of \$10,000, or even much more.

We do not deem it necessary to refer very particularly to the editorial management. The paper is totally distinct from its predecessor of the same name, published some time ago in New York City. It is conducted by Mr. Samuel Scudder, of Cambridge, Mass., as editor-in-chief, who will be assisted by the most able men in the country in their various departments.

Science will be published in Cambridge, but subscriptions may be sent to the publishers of this Journal. The subscription price is \$5 per year, in advance. We unhesitatingly commend *Science* to the support of every person interested in any branch of scientific study, confident that it is sure to meet the wants and obtain the approval of all.

THE PROJECTING MICROSCOPE FOR CLASS DEMONSTRATIONS. — When the microscopist attempts to project the

images of minute objects upon a screen, so as to make them visible to a large audience, he meets with a difficulty which thus far has not been satisfactorily overcome, viz., a great loss of light. With low-power objectives the larger objects, such as whole insects, sections of large-celled plants, entomostraca, etc., can be shown fairly well; but when higher powers are employed the result is very disappointing. We have seen the blood corpuscles coursing through the vessels in a frog's foot depicted on a screen in a large hall, so that they could be distinguished at a distance of several feet, but such demonstrations are not very striking; and it is not possible to make them satisfactory before a large audience. The principal difficulty is to obtain sufficient light. The projecting microscope has not been perfected. No doubt it is capable of doing much more than it can do in its present form; and there seems to be an excellent opportunity now for some ingenious optician to devise a better one.

The purport of this article is not to suggest a new form, but we may incidentally remark that the improvements to be made are mainly in the apparatus for condensing the light upon the object. Specially constructed objectives will doubtless be demanded after a while, but good low-powers for the purpose can be selected from among those now in use. We have yet to see a really good apparatus for condensing the light upon the object. The problem offered to the optician does not seem to be a difficult one, and it is strange that it has not been solved ere this.

For the present it is useless to consider the advantages of a projecting microscope for purposes of instruction in large halls, but we have long held the opinion that it would be of great assistance to professors in medical colleges, while lecturing before small classes, and also to other teachers, if a projecting microscope could be devised, giving a field of only two, or at the most three feet in diameter, but

showing very minute details of structure clearly and well illuminated with high powers. Such an instrument would surely be of very great assistance to the teacher of animal or vegetal histology; for he could point out the details of structure, and designate particular features of the specimen so that there could be no misapprehension as to the structure referred to. Such demonstrations would be far preferable to the use of drawings and photographs, and even better than the examination of the specimen by each student in the ordinary way, under the microscope, for then there is always some uncertainty whether the student sees just what it is desired he should see. If the lecturer could show the specimens by means of the projecting microscope, and thus have them before his class while describing them, it certainly would be a great advantage.

We are confident that it is entirely practicable to do this. It remains to be seen who will undertake the construction of the proper instrument.

NOTES.

—We have received an excellent 5 x 8 photograph of Dr. William B. Carpenter, taken, while he was visiting this city, by A. Bogardus. As many of our readers would, doubtless, be pleased to obtain copies of this picture, we take pleasure in saying that they can obtain them, for 50c. each, by applying to Mr. Bogardus, at 872 Broadway.

—A very excellent address was recently delivered before the Postal Microscopical Society (London) by the President, Mr. Arthur Hammond. The subject was "The Structure and Economy of the Daphnia," a subject well chosen and well treated. The entire address is published in the Society's *Journal* of December, 1882, illustrated with two plates. It is well worth reading by microscopists who desire to know more about the common daphnia than is to be learned from the text-books.

—Dr. Allen Y. Moore prepares slides of crystals in this way: a cold, saturated solution of the salt is made, which is

then heated so that it will dissolve still more of the salt. A cell is then filled with the warm solution, and immediately sealed. Upon cooling, the crystals will be deposited within the cell in a most beautiful manner, and their lustre is retained. Glycerine is sometimes used as a solvent. Gold-size is recommended as a suitable cement.—*The Microscope*.

—Mr. L. Schrauer, of New York, has devised a new form of nose-piece for microscopes, to facilitate the changing of objectives. It consists of two parts: the upper part screws into the ordinary nose-piece, where it is to remain permanently attached; the lower part, called an adapter, carries the objective. There must be an adapter for each objective, and objectives are changed by sliding the adapters out and in, no screws or springs being required. We find it difficult to describe the apparatus satisfactorily, although it is extremely simple.

—The co-partnership hitherto existing between the firm of R. & J. Beck, of London, and Mr. Charles Coppock, having come to an end by the limit of time, Mr. Coppock has gone into the business of a practical and manufacturing optician on his own account, and has established his business at 100 New Bond Street, London.

—*The Sanitarian*, published in New York, begins its eleventh volume as a weekly quarto of 16 pages, printed in clear type, on good paper. We congratulate the editors upon the prosperity of the magazine, which occupies a field in which there is an opportunity for doing much substantial good for every city and community.

—*The New York Medical Journal*, which has reached its thirty-seventh volume, began as a weekly with the number of January 6th. That number opens with the first of the series of lectures on human automatism, delivered at the Lowell Institute, Boston, by Dr. W. B. Carpenter. In its present form the *Journal* will, doubtless, meet with still greater favor than in the past among practising physicians.

—We have received the October number of Mr. Thomas Bolton's "Portfolio of Drawings and Descriptions of Living Organisms." It is a very useful publication, if all the numbers are equal to the one before us, and if it were better known in this country, no doubt it would be

valued by many who are interested in pond-life.

—If the United States Congress desires to do something for the benefit of the country at large, it might well follow the example set by the French Minister of Agriculture, who has placed \$10,000 at the disposal of M. Pasteur, to continue his investigation of contagious diseases of animals. Does Congress know how much money the Department of Agriculture of this country has saved through such investigations already made with entirely inadequate means? When the money value of such investigations becomes known, \$10,000 will seem like a very small amount to be annually appropriated to this one purpose.

CORRESPONDENCE.

TO THE EDITOR.—In the December number of your JOURNAL, in the review of the *Proceedings* of the American Society of Microscopists, you make, unintentionally no doubt, some unjust comments on the article on the Fasoldt Stage Micrometer, which I prepared for the Society, and which was published in the *Proceedings*. When you intimate that an injustice had been done Professor Rogers, it would almost seem that you had not read the paper, but had only glanced at certain portions of it. It will be remembered that the special object of the work was the measurement of the Fasoldt plate, which had been turned over to me by the Society for that purpose. The measurement of the two or three other micrometers was made solely for the purpose of comparison, that the reader might be able to see something of the regularity with which such plates run. They were all plates which I happened to have at my command, and I made no assertion that they represented the best work of their respective makers. In the case of the Rogers plate, I expressly stated that the work was by no means up to the standard of his recent rulings, and I was glad to avail myself of the opportunity offered by Gov. Cox to examine a more recent micrometer. The measurement of this plate was made at some personal inconvenience, in order that the result might be included in the report, and to remove any suspicion of a desire not to represent Professor Rogers fairly, it is

only necessary to quote the following from the paper referred to:—

"It will be seen, however, that the plate makes a better record for uniformity than any other micrometer examined. In width of space it lies between the Fasoldt $\frac{1}{1000}$ inch and $\frac{1}{5000}$ inch groups; the deviation from the mean in the first is somewhat more than one per cent., while in the new Rogers it is only about eight-tenths of one per cent., and this, too, with only two measurements of each space, against five for the Fasoldt."

Finally, it seems hardly worth while to refer to the intimation contained in your notice that possibly there may have been a desire to "demonstrate the imperfections in Professor Rogers's rulings" in the selection of a "particular micrometer" for measurement. The plate used was one which was purchased of Professor Rogers several years ago by Professor Tuttle, and was the first of its kind ruled by him. Just what plate it is, is perfectly well known to Professor Rogers, and, as far as the writer knows, its "tale" is certainly "plain, unvarnished," and, I may add, devoid of any special interest.

No one has higher respect for the most excellent micrometric work of Professor Rogers than the writer, and no one has for him a warmer personal regard.—Yours respectfully,

T. C. MENDENHALL.

[If the reader will refer to our article on page 236 of the December number, he will see that our remarks were not calculated to do injustice to anybody. We still regard our question, "Why the measurements were published at all?" as a pertinent one, in view of the statement by Professor Mendenhall that the plate measured "does great injustice" to Professor Rogers. We can understand, and so can all others who are familiar with Professor Rogers's work, that that imperfect plate does not indicate in any way "the regularity with which such plates run." But how can the great mass of readers know this? No matter what the intentions of the writer may have been—and surely we do not wish to misinterpret them—we do know that there are some persons who are only too glad to use the published results to show that Professor Rogers's work is not uniform, and, perhaps, we are a little impatient when we see anything that seems in the least unfair in this connection.

Professor Mendenhall has quite misconstrued our language when he alludes

to our "intimation" of a desire, on his part, to "demonstrate imperfections in Professor Rogers's rulings, etc." We made no such intimation whatever, as any one can readily see. But we have been informed that a certain plate by Professor Rogers, known not to be one of his best or latest ones, has been used at Albany to demonstrate the superiority of Mr. Fasoldt's rulings over his own. It is such unfairness that receives our condemnation at all times, and we can only hope that the rumor is unjust to Mr. Fasoldt.—ED.]

TO THE EDITOR.—Having studied, during the past summer, some of the infusoria of this locality, I send you a list of the same:

FRESH WATER ALGÆ.—*Hyalotheca dissiliens* Desmidiū *Swartzii*, *Micrasterias denticulata* and *truncata*; *Euastrum oblongum*, *Cosmarium margartiferum*, *Closterium moniliferum*, *Staurastrum alternans*, *vestitum*, *paradoxum bracheatum*; *Pediastrum tetras*, *biradiatum*, *pertusum*, *Spirogyra* and *Volvox Globator*.

DIATOMACEÆ.—*Cocconeia lanceolata*, *Synedra capitata*, *ulna*, *Gomphonema capitatum*, *Surriella*, *ovata*, *Navicula*, several species.

RHIZOPODA.—*Amoeba proteus*, *verrucosa*, *radiosa*, *villosa*, *Diffugia pyriformis*, *urceolata*, *lobostoma*, *corona*, *constricta*, *Arcella vulgaris*, *mitrata*, *Euglypha alveolata*, *ciliata*, *Assulina seminulum*, *Trinema enchelys*, *Actinophrys Sol*, *Acanthocystes*.

INFUSORIA.—*Ceratium longicorne*, *Melodinum uberrimum*, *Paramecium aurelia*, *Coleps hirtus*, *Colpoda cucullus*, *Trachelocerca versatilis*, *Lacrymaria*, *cohnii*, *Spirostomium ambiguum* or *Heterotricha*, *Leucophrys virens*, *Stentor polymorphus*, *Stentor multiformis*, *Gyrocotis Oxyura*, *Vorticella nebulifera*, *putrinum*, *microstoma*, *epistylis*, *Ophrydium echornu*, *Kerona polyporum*, *Gastrostyla steinii*, *Trichoda lycus*, *Podophrya*, *Quadrupartita*, *Acineta Mystacina*, *Notus*, *quadricornis*, *Brachionus Pala*, *Mornocerca rattus*, *Dinocharis pocillum*, *Stephanops lamellaris*.

These are a few of the multitude of the creatures that abound in the lakes and ponds in this locality. Not having access to a good work on the Algæ and Diatomaceæ there are many forms that I cannot identify.—Yours, etc.,

J. W.

Minneapolis, Minn.

MICROSCOPICAL SOCIETIES.

At a recent meeting of the CAMDEN Society, Mr. J. L. De La Cour read an exceedingly interesting paper upon "Sporendonema; or, the Fungus which is Now so Prevalent Among House-flies." It is a common occurrence in autumn, he said, to find the house-fly dead, adhering to the wall or window-panes, firmly fixed by its tongue, with legs spread out. In about twenty-four hours after death a fleshy, white substance is found in the form of a ring projecting out between each section of the abdomen. This is caused by the presence of a minute fungus, *Empusa musci*, and in its fully developed condition the spore-bearing filaments of the plant stand out from the body of the fly like a pile of velvet, and the spores thrown off from these in all directions form a white circle around it as it rests on the glass. The filaments which show themselves are merely the fructification of the fungus, the plant itself being within the body. It originates in minute corpuscles, which find their way into the circulation from without, either by the deposit of a spore on some part of the body, penetrating through the rings or spirals, and when once established gives rise to mycelial structure, developing subsequently into ripe spores.

Dr. Brown made some interesting remarks upon the subject of artificial food for infants, and exhibited specimens showing that they were really deficient in those elements most essential.

Mr. Morrison exhibited specimens of pure ground ginger, and also specimens of adulterated ginger. Mr. Bowden exhibited specimens of pepper, and Mr. Derosse a specimen of material used for adulterating black pepper. Remarks upon these objects were made by several of the members.

A meeting of the CAMDEN Society was held December 7th, Dr. A. P. Brown in the chair. Mr. Brown called the attention of the members to the important fact that nearly all kinds of bitter drugs, such as nux vomica, chamomile, etc., have lately greatly advanced in price, owing to the large purchases made by brewers, who use them in the manufacture of beer in the place of hops, of which the crop this year was a failure.

Mr. A. P. Brown then gave an instructive lecture on section cutting, straining,

and the mounting of different kinds of woods, showing that many vegetables can be softened and thoroughly preserved in a mixture of alcohol, water, and glycerine. Some woods need boiling in water and then placed in the above mixture. To cut the sections, several inventions were shown, but it was decided that a razor, ground flat on one side, was as good as any of them. After the sections are cut they should be placed in alcohol, to prevent shrinking, and for bleaching the same a labarraques solution should be used.

Mr. L. T. Derosse called the attention of the members to an insect called the "Weaver," which, although so small it could hardly be seen by the naked eye, was a most destructive insect. The gentleman had some Indian corn which had been bottled up for over a year, and every grain had been so catcombed by these insects that nothing but the shell remained.

When placed under a microscope, the weaver looked about the size of a lobster, and not unlike it, only that it appeared covered with tiny silver spots.

The society are now in possession of Cole's "slides and studies," and after a long controversy, it was decided that they should be divided into four parts of thirteen each, and that members should be allowed the privilege of taking them to their homes, but they should be at the society room on each meeting-night.

The second annual *soirée* of the FORT WAYNE Academy of Science and Microscopy, was held on the evening of Nov. 30th. The President, Dr. C. R. Dryer, delivered the inaugural address, entitled, "The Materials of Life," and a fine collection of objects was exhibited.

NOTICES OF BOOKS.

How to make Pictures. Easy Lessons for the Amateur Photographer. By Henry Clay Price. Second edition. New York: Scovill Manufacturing Co. (pp. 72. Price 50 cents.)

The second edition of this very useful work was called forth in about two months after the first edition was published, which is good evidence of its popularity and value. A short chapter has been added on photography with the microscope.

Acephalis. Etudes locales et Comparatives. Extraits du systeme silurien du centre de la Bohême. Vol. VI. *Acephalis.* 10 Planches. Par Joachim Barrande. Chez l'auteur et éditeur: Prague and Paris, 1881. (pp. 536.)

This is the latest of a large number of valuable works by the same author, describing and illustrating fossil remains of shells in the rocks of Bohemia. These works are all especially valuable for the excellence of the illustrations, many of which are not to be surpassed.

Nervous Force: Its Origin and Physiology. By W. C. Barrett, M.D., L. D. S., Buffalo, N. Y. Read before the American Dental Association at its twenty-second annual meeting, held in Cincinnati, Aug. 1-5, 1882. (Pamphlet, pp. 16.)

New Commercial Plants and Drugs. No. 6. Part I. Fibres: Their Botanical Sources; The Methods of Examining them under the Microscope, and their Treatment by the Ekman Process. Illustrated with six colored plates. Part II. New Plants and Drugs: Their Cultivation and Uses. By Thomas Christy, F. L. S., with the kind assistance of M. Vétillat, of Paris. London: Christy & Co. 1882. (Pamphlet, pp. 116. Price 2s. 6d.)

This is a very useful publication for those who are interested in the application of fibres to the manufacture of paper or textile fabrics. It contains much information of a thoroughly practical kind, and the illustrations are good.

Biological Atlas. A Guide to the Practical Study of Plants and Animals, Adapted to the Requirements of the London University, Science and Art Department, and for use in Schools and Colleges, with accompanying text, containing arrangement and explanation, equivalent terms, glossary, and classification. Four hundred and twenty-three colored figures and diagrams. By D. M'Alpine, F. C. S., and A. N. M'Alpine, B. Sc. (*Honours*). Lond. Edinburgh and London: W. & A. K. Johnston. 1880.

In attempting to give a suitable notice of this excellent Atlas, we can do no better than to quote a few lines from the Preface: "It is now generally recognized that a certain acquaintance with actual specimens is necessary for the proper un-

derstanding of plants and animals. By the practical study of representative forms, exemplifying the leading modifications of plant and animal life, the student obtains a basis of distinctly observed fact with which to compare other forms, and round which to cluster the information derived from books.

"The University of London has given practical shape to this idea by selecting a series of common types, which 'each candidate must be prepared to examine microscopically, to dissect and to describe.'

"In this Atlas, which is intended to serve as a guide to, and not as a substitute for, practical work, drawings are given of the various points of importance exemplified by each of these types to enable the student to make out the points for himself on the actual specimens."

It is no detriment to a work of this kind that the figures are, to a certain extent, diagrammatic. They represent the structures described very clearly, and must prove of great use to the student in dissecting.

Exchanges.

HAVING LOST my List of Exchange indebtedness, I would be glad if those to whom I owe slides would send me a memoranda of same, and oblige J. Ketchum, Box 877, New York City.

FOR EXCHANGE.—Mounted or unmounted, the beautiful seeds of the insectivorous plant, *Drosera longifolia*. Rev. E. A. Perry, Palmer, Mass.

MARINE ALGAE and Diatomaceous earth in exchange for Histological and Pathological slides, or minerals. R. Cauch, M.D., Carpenteria, Cal.

WANTED.—Well-mounted slides of Coal and Coal products in exchange for slides or material for mounting. Address, J. C. Lathrop, Bridgeport, Conn.

FOR BLADDERS of Utricularia (Insectivorous Plant), send stamped envelope to Allen Y. Moore, M.D., 53 Prospect Street, Cleveland, O.

SECTIONS of Frog's tongue, Cat's tongue (polariscope) and Skin of Index finger, for other well-mounted objects. F. B. Carter, 519 Gates Av., Brooklyn, N. Y.

SLIDES of arranged diatoms, also of selected diatoms, to exchange for cleaned diatomaceous deposits. Now on hand, slides of *Aulacodiscus Crux*, E.; *Rhabdonema Myrificum*; *Aulacodiscus Orientalis*; *Campyloneis Grevillei*; *Heliopelta Selliguerii*; *Craspedodiscus elegans*; *Climacodiscus Moniligera*. H. P. Malory, Utica, Oneida County, N. Y.

FIRST-CLASS slides in exchange for unmounted Animal Parasites, a liberal exchange given for quantities. John Walker, 810 12th Av., S. Minneapolis, Minn.



Fig. 1.

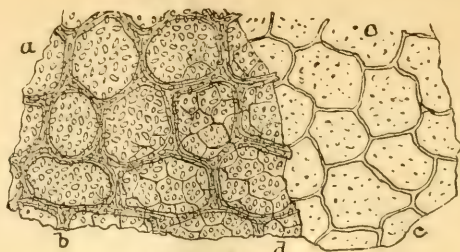


Fig. 2.



Fig. 3.



Fig. 4.

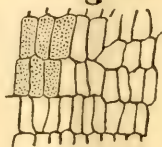


Fig. 5.



Fig. 6.



Fig. 7.

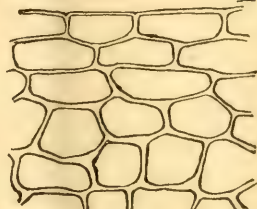


Fig. 8.

Fig. 9.



Fig. 10.

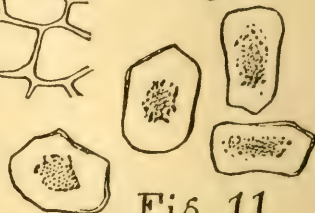


Fig. 11.

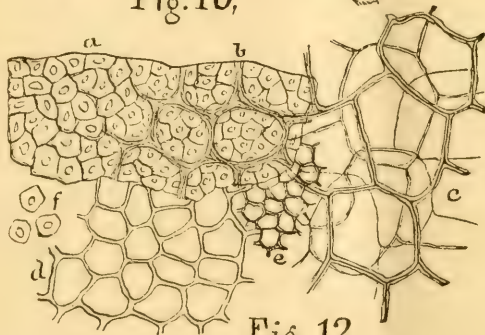


Fig. 12.

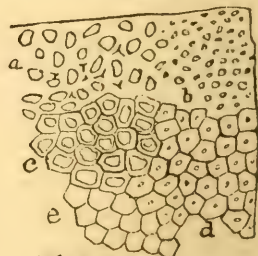


Fig. 13.

1. Dry seed, opaque by $\frac{1}{2}$ -in. objective.
2. Shell of dry seed in turpentine; *a*, substance of the shell; *b*, ridges of outer surface; *c*, membrane of outer surface; *d*, inner membrane, $\times 275$.
3. Section of dry seed shell $\times 250$.
4. Section of dry cotyledon $\times 250$.
5. Section of same in water $\times 250$.
6. Separated cells of seed; *a*, of cotyledon; *b*, of radicle, $\times 275$.
7. Fragments of mustard flour $\times 250$.
8. Section of cotyledon cleared in potash $\times 500$.
9. Granules resembling starch, by 1-10-in. H.I. objective.
10. Section of soaked seed shell, the ridges swelled up and membrane raised up from the pits of the surface.
11. Cells of outer membrane, in glycerine $\times 250$.
12. Piece of seed shell macerated in acid; *a*, cells of the husk; *b*, ridges of the surface; *c*, cells of outer membrane, distended; *d*, cells of inner membrane; *e*, true membrane of husk cells; *f*, separated blocks of the shell.
13. Appearance of shell and section; *a*, in water, by $\frac{1}{2}$ -in. objective; *b*, by 1 in.; *c*, macerated in potash; *d*, in acid; *e*, in acid, by $\frac{1}{2}$ -in. objective.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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BOSTON, FEBRUARY, 1883.

No. 2.

Unicellular Algæ.

When we examine those simple forms of life which consist of single, isolated cells, we are at once met with the query whether they are mature living organisms, or only transitory stages in the life-history of more complex forms. The answer to this question is only to be given after long and uninterrupted observation. We have only to recall the method pursued by Drs. Dallinger and Drysdale, in their studies of the life-history of certain monads, which required constant watching of single forms for days and nights, to form some idea of the trying nature of such investigations. If it were, indeed, necessary to study all the unicellular forms of life in this way, we might well despair of ever knowing much more about their different stages than we do now. But, fortunately, such continuous watching is not always necessary. In many cases it is so, and especially in the study of the lower forms of animal life, which usually pass most of their life in a motile condition. Among the simplest plants, however, the motile stage is seldom of long duration. While there are algæ which pass most of their life in a free-swimming stage like *Volvox*, and its allies *Pandorina*, *Gonium*, *Chlamydomonas*, with *Oscillaria* and certain diatoms, yet the vegetative life of the algæ is usually passed in a state of rest. Generally the motile condition serves the purpose of propagation.

Among the phænogamous plants, various beautiful arrangements are found calculated to assist in the dissemination of the seeds through the air. There is the pappus of the dan-

delion and thistle, the winged seed of *Catalpa*, the coma of the cotton-seed, all of which are well calculated to spread the seeds far and wide. For plants living in water there must be some other means of disseminating the spores, or germs, and we find that most of the algæ and submerged fungi produce free-swimming cells, commonly termed swarm-spores because of their swarming out of the cells in greenish, or colorless, cloud-like masses, also known as zoospores because of their animal-like movement.

Swarm-spores are spherical or oval masses of protoplasm, or, perhaps, of protoplasm including other cell-contents, for they are formed directly from the living matter of cells which, at a certain stage of growth, contracts into one or more balls within each cell, and finally escapes by the rupture of the cell-wall. Each swarm-spore is provided with one or more whip-like appendages, by means of which it swims through the water. The method of propagation by swarm-spores is well illustrated by the very common filamentous alga *Chaetophora*, which is represented in fig. 6, a, showing the swarm-spores escaping from the apical cells of one of the branches.

After a short time the swarm-spores come to rest, and then they may either grow directly into new plants, or, becoming spherical and losing their cilia, they may multiply for many generations, by a process of cell-division, before again extending into filaments like the plant which produced them.

It is this stage of growth which is so puzzling to the student of the algæ, and it may be desirable to consider it

more fully; but since the literature of the subject is so meagre and scattered, comparatively little can be said about the life-history of swarm-spores. From what has been already said of the production of swarm-spores, it will be understood that these are not usually, the product of any process of conjugation. They are purely a sexual elements. In a few cases such swarm-spores have been observed to conjugate after emission; but this is a rare occurrence, and whether it is indicative of any distinction between the coalescing gonidia is uncertain, and, it may be added, improbable.

The plant *Ulothrix*, which is very common about here, propagates by the production of a single swarm-spore in each cell. This plant is represented in fig. 6, *c*, with a swarm-spore just making its exit from a cell, and another swimming away from the empty cell at *b*. I have often watched these swarm-spores making their exit in clouds from a collection of *Ulothrix* in a saucer. Usually I have observed them to grow directly into new filaments; but probably they sometimes become spherical and surrounded by jelly, and multiply in that condition. Mr.

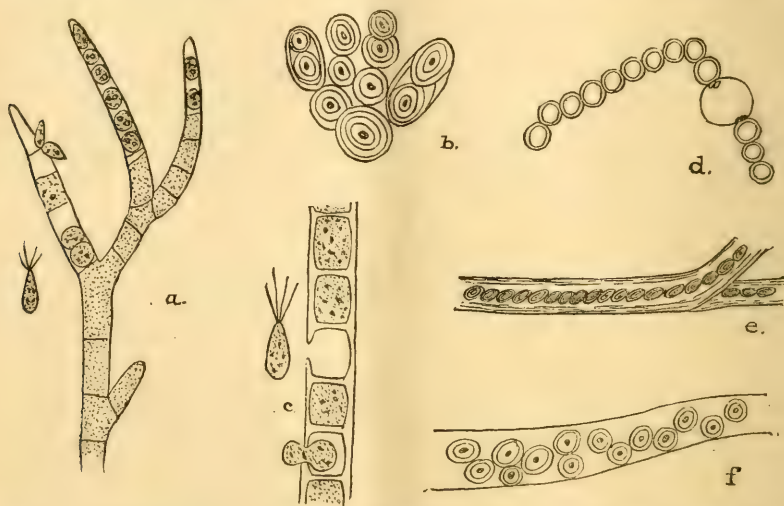


FIG. 6.—*a*, CHÆTOPHORA; *b*, GLÆOCAPSA; *c*, ULOTHRIX; *d*, NOSTOC; *e*, SCYTONEMA; *f*, SIROISIPHON.

Among the Phycocromophyceæ, or dark, olive-green algæ, there are classed a number of unicellular plants under the generic name of *Glæocapsa*, of which Rabenhorst describes over fifty species. This alga consists of single, spherical cells, surrounded by a wide, mucilaginous layer, showing numerous concentric rings (fig. 6, *b*). These cells seem capable of multiplying indefinitely; but under some conditions, according to the Rev. Mr. Wolle's observations, they develop into filamentous plants, as *Siroisiphon*, (fig. 6, *f*), or *Scytonema* (fig. 6, *e*).

Wolle believes that the green cells found growing on board fences, tree-trunks, and in similar places, which are known as *Pleurococcus*, are merely the spores of *Ulothrix*. This pulverulent *Pleurococcus* consists of small masses of spherical cells. I have been studying it for some time, hoping to induce the ulothrix-filaments to grow; but up to this time, they have not been produced.

Another plant known as *Nostoc* (fig. 6, *d*), Mr. Wolle believes to be a developmental form of *Scytonema*, which may be regarded as a *Nostoc* en-

veloped with a sheath, as shown in fig. 6, *c*.

Itzigsohn, more than twenty-five years ago, found that *Hapalosiphon Braunii*, a plant allied to *Sirosiphon*, (fig. 6, *f*), also developed from a *Nostoc*, or a *Microcystis*.

It will be seen, therefore, that the study of the unicellular forms should first be directed to solving the question of their origin or future growth. When we consider that the swarm-spores, when once they pass into the stage of unicellular, vegetative growth, or multiplication, may give rise to many generations of new cells before resuming the parent form, the tedious nature of such investigations must be self-evident. But, more than this, even these unicellular forms vary in appearance under different conditions of moisture, and give rise to a polymorphism which may be exceedingly confusing. It is often utterly impossible to distinguish between the swarm-spores of very different plants, except by following their life-history. Separate the gonidia of a lichen, and compare it with some spores of algæ, and it is impossible to distinguish them apart. What, then, shall be our generic or specific characteristics for the algæ, if we cannot even tell an alga from the gonidia of a lichen?

It would be useless to attempt to answer this question in the present state of our knowledge. The evidence seems indisputable that many of the forms now classed as unicellular algæ are but the propagating spores of higher algæ. However, it does not follow that there are no algæ which attain their full development as single cells.

It has been thought by some that there must be a process of conjugation sometime in the life-history of every plant, to insure its continued existence. Conjugation is the union of two elements which may be distinguished as male and female. Among these low plants, however, no such distinction can be recognized, and it may be fairly doubted if it

exists at all. It may be that the two swarm-spores that unite, as before described, are no more different than any two other protoplasmic cells, and yet by their union they may serve to perpetuate the species. It should be remembered that in these lower plants all the functions of life reside within each single cell, and it seems impossible that the differentiation of special male and female elements or cells, should be manifested so low in the scale of life.

Among the green-celled, gelatinous algæ it is a hopeless task to draw a line even between the genera, to say nothing of the species. We may say, in general terms, that a gelatinous layer containing green or brown, spherical or oval cells irregularly scattered through it, is a *Palmella*; when the green cells are arranged with some regularity in groups of four, we have *Tetraspora*. In typical forms this distinction is clear enough, but in practice it will be found that it is not easy to always tell to which of these genera the plant belongs. So it is throughout all the unicellular plants,—the species and the genera run together. Take, for instance, the two plants *Glæocystis* and *Glæocapsa*. The latter is shown in fig. 6 *c*, the former only differs from *Glæocystis* in the color of the chlorophyll, which is of a brighter green. It is probable that many of the lower algæ that are now regarded as belonging to distinct genera, will eventually be found to be only different stages of development of other algæ, or in many cases, modified forms of growth produced by the conditions of life, such as the greater or less abundance of water, the rapidity of growth, etc.

Such a supposition finds some support in the fact, well known to students of the algæ, that certain forms will be found in a pulverulent condition in dry weather, while with abundance of water a gelatinous investment surrounds them. It follows that the generic name of an alga will sometimes change with the habitat. *Glæocystis*, for example, is found upon

moist rocks, wood-work, etc., but not in water.

If we follow the life-histories of some of the lower algæ, we find strong evidence that their complete cycle is passed as unicellular plants. They have been studied with great patience, and it has been found that some of them, under certain conditions, will multiply for generations without change, but under other conditions, the cells will give off swarm-spores in abundance. A few of them have been observed to grow into filamentous plants. But I am not yet willing to admit that all these simple algæ are sporules of more complex forms. The facts stated by Paul Richter in regard to *Glæocystis* and its cycle of growth,* seem to preclude the supposition that this plant is a developmental stage of a filamentous plant. He has shown a genetic connection between *Glæocystis* and several other forms of equally simple structure,—*Glæocapsa*, *Cylindrocystis*, *Microcystis*, and *Palmella*, but no tendency to further development of the individual cells of *Glæocapsa* has been observed. It seems probable, however, that the cells of this plant sometimes grow in sheaths, forming *Sirosiphon* (fig. 6, *f*), but we may question if this is truly a higher stage of development.

Richter has also endeavored to establish a genetic connection between a number of other genera, and he regards *Aphanocapsa* as an intermediate form between *Glæocapsa* and *Glæothecæ* or *Aphanothecæ*.

A short *résumé* of the relations between some of the simpler algæ according to the latest observations, may prove interesting as well as an aid to the memory in classifying them. The two large classes of Phycophyceæ, and Chlorophylophyceæ, so-named from the color of the cells, which in the former are yellowish, brownish, or dark-green, and in the latter bright-green, have corresponding genera. The naked, single cell

plants, usually living in a layer of clear, homogeneous jelly, are, in the two classes, respectively *Aphanocapsa* and *Palmella*.

From these we naturally pass to the encysted forms *Glæocapsa* and *Glæocystis* already mentioned (fig. 6, *b*). If the gelatinous investment is wanting, we have *Chroococcus* and *Eremosphæra*, and when the cells are segregated in families the *Pleurococcus* found on tree-trunks, fences etc. *Glæocapsa* has been observed to grow into *Scytonema*, and *Sirosiphon* (fig. 6, *f*), to which it bears the same relation, in form if not in fact, as *Glæocystis* to *Hormospora*.

There are many forms consisting of a spherical, more or less gelatinous envelope enclosing numerous green cells. These may be regarded as derived from the gelatinous, encysted forms like *Glæocystis*. The filamentous algæ are undoubtedly derived from simple cells which at some time were caused to elongate and grow in a certain direction. Perhaps the transition forms, in this process of development, are to be seen in the cylindrical cells of *Glæothecæ*, *Aphanothecæ*, etc. The beautiful sphere of *Volvox* seems very complex, yet what difference can we distinguish between the individual gonidia of the sphere, and the motile form of *Proococcus* with its gelatinous investment through which the flagella extend?

The study of algæ is very fascinating, and such questions as we have raised in this article indicate a wide field for original investigation and discovery.

The Detection of Adulteration in Food.

BY C. M. VORCE, F.R.M.S.

MUSTARD.

This condiment, of so universal use, is probably never obtained strictly pure. The commercial article

* This JOURNAL, ii. pp. 25, 52.

is the flour of the seeds of black mustard and white mustard mixed in a proportion that varies with the fancy or honesty of each manufacturer; the black mustard seeds furnishing the best mustard flour. To the mustard flour is added a large proportion of wheat flour, which serves to absorb and retain the abundant oil of the crushed mustard seeds, and it thus ranks as commercially pure. A celebrated English manufacturer of mustard uses 56 lbs. of wheat-flour to 112 lbs. of mustard-flour made from two parts of black to one part of white seed. This mixture is accepted as a very superior article of "pure ground mustard." In cheaper grades of mustard the proportion of wheat-flour is increased, the sifting out of the mustard seed husks is less perfect, rye-flour and other cheaper flours and corn meal are used, and various adulterants are added, of which one of the most common is turmeric, as it also serves to darken the yellow color of the mixture when much starchy flour is used.

The mustard seed itself is also subject to adulteration, but not extensively, cheaper and harmless seeds being mixed with it, clove seed being the most common. The appearance of the mustard seed under the microscope is beautiful indeed, the surface is covered with a net-work of raised ridges enclosing shallow concave pits of rudely hexagonal shape, smaller and more irregular as they converge toward the micropyle of the seed, and containing a shrunken membrane-like layer of glistening white substance lining the sunken cavity, and in some places looking like a flat scale-like crystal lying in the pit, Plate V, fig. 1. The shell or husk of a dry seed examined in turpentine or water, exhibits a rudely hexagonal areolation, and is apparently thickly punctured with small holes, and of a somewhat translucent red color, like colored horn, fig. 2, *a*. The seed-shell is lined inside and out by a thin, close, cellular membrane, the outer one with very

much larger cells than the inner, and having a dented appearance, Fig. 2, *c*. The inner membrane is entirely hyaline and glass-like, and when viewed on the inside of the dry seed-shell, by lieberkuhn, it appears to be the inner surface of the husk itself, composed of small irregular cells having a sunken appearance and a bright blood-red color. This inner membrane, in fact, adheres so closely to the shell as to almost universally follow its fracture, and so is seldom seen projecting from the broken edge of the husk as the outer membrane often is, (fig. 2, *c*), but on taking a seed that has been soaked for a day or so in water, or for a short time in dilute nitric acid, and squeezing out the cotyledon, the outer and inner membranes will be found swelled and softened, and can be scraped off with needles and examined separately. The inner one then appears as in fig. 12, *d*, and the outer one, much more swollen, as in fig. 12, *c*.

The structure of the substance of the seed-shell is very peculiar and complex, and more space than is at command would be required to describe it fully. Its appearance, so far as identification is concerned, is, however, distinctive and easily recognized. When untreated the shell presents in water, turpentine, or glycerin, the appearance shown in fig. 2, *d*, when viewed with the inner surface uppermost: the ridges of the outer surface (*b*) are indistinctly seen through the shell, which appears to be composed of rudely hexagonal blocks containing, each, several of the small holes (*a*) with the large-celled, mottled or dented outer membrane (*c*) projecting in places. The appearance of hexagonal blocks is caused by the cell-walls of the inner membrane, for when this is scraped off, no such appearance is seen (fig. 2, *a*). By soaking the shell in potash or acid it is made apparent that each hole is in a separate block, for these are clearly seen, fig. 12, *a*, and can be picked apart with needles, fig. 12, *f*. The seed-shell has, however,

a lining membrane to these blocks, for in a piece treated in acid and picked apart with needles, not only the outer membrane, fig. 12, *c*, the inner membrane, fig. 12, *d*, and the separate blocks (*f*) of the shell are seen, but also a smaller-celled membrane, whose meshes correspond in size and shape to the blocks of the shell substance, fig. 12, *c*. In fig. 13 are shown the different appearances of the seed-shell under various treatments, and also in section.

In the preparation of ground mustard, repeated sifting is resorted to to remove the fragments of the seed-shell, called "husks," but minute fragments will be found in all samples if they contain mustard at all.

The cotyledon of the mustard seed is composed of elongated cells arranged in pretty regular rows lengthwise of the seed, (fig. 4). In most parts these rows are very regular and the cells of even size, (fig. 5). The cells of the radicle are long and slender, fig. (6, *b*). By chopping up with a knife the cotyledon of a soaked seed and crushing down the fragments in water, the separated cells will be seen, (fig. 6). As seen in the mustard flour, the fragments of ground mustard will present small irregular lumps of cells, of various sizes and shapes, opaque in the thicker parts, and with the cells filled with a minute granular substance, (fig. 7). Some scales and cells of the outer membrane of the shell, (fig. 11), are seen, some separate cells of the mustard seed, (fig. 6), and a very few minute fragments of the shell.

The mustard seed is, by some, said to contain no starch at all; by others to contain "little or none," and by others to contain "very little," "but a trace," etc. I have not been able to satisfy myself of the presence of starch in the mustard seed, but the cells of the cotyledon are filled with minute granular matter, (figs. 4, 5, 6, 7,) which almost entirely dissolves in potash with heat, leaving the cells empty with their cell-walls thickened,

(fig. 8,) and in the water in which a dry seed is crushed, can be seen numerous minute drops of oil, similar to what was figured in the article on Capsicum, and many very minute granules, (fig. 9,) which are solid and clear, and float in the water; they dissolve in potash but do not polarize, nor do they seem to stain by dilute iodine, and they do not swell appreciably on being heated in water. I could discover no trace of a hilum, but am inclined to believe from analogy that these minute granules are, in fact, starch.

In examining samples of ground mustard to detect adulteration, first drop a little into alcohol and see if it instantly gives the yellow color indicative of turmeric; if so, place a little in water under the microscope and determine as nearly as possible the percentage of turmeric present, also note the proportion of wheat-flour, and whether any other starchy matter is present. The addition of dilute iodine will mark the starches, leaving the fragments of mustard uncolored, and thus facilitate the determination; finally add strong potash solution and note what proportion is left after all the starch is dissolved. A fresh sample should also be examined in turpentine, and another should be treated with nitric acid, by which means any fragments of other seeds than mustard will be detected, and lastly, still another sample should be treated with potash and heat, and examined for fragments of seed-husks other than mustard husks. Acid after potash will often soften woody fragments that resisted the potash, and enable their structure to be detected.

Some Minute Plants.

A small, homœopathic vial which was handed to us recently by Mr. A. D. Balen for the examination of certain specimens, after standing for sev-

eral days in a warm room, was again taken up and a drop of the water was placed under the microscope. It was very rich in a number of minute algæ, which are to be found in almost every collection, after it has stood for several days. These minute plants are often very puzzling to the microscopist, and the effort will be made in this article to indicate what they are. The reader may obtain them very easily at any time of the year by placing a glass of water with a blade of grass or any bit of plant in a warm, light room, for several days.

The first alga that will probably be observed, is one that was very abundant in the bottle referred to. It is represented in fig. 7 *a a'* and is known

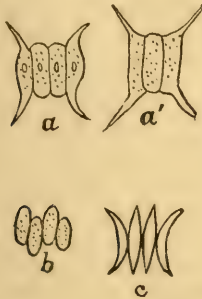


FIG. 7.—SCENEDESMUS.

as *Scenedesmus quadricaudatus*. Almost invariably, when this plant is abundant, it will be associated with another of the same genus, *Sc. acutus*, *c*, and in this case we also found *Sc. obtusus*, *b*. The first-mentioned species varies greatly in size. The bright-green cells measured from 5.8μ to 14.5μ in length ($.00023$ to $.00057$ inch) and 2.2μ to 4.3μ in breadth ($.000066$ to $.000172$ -inch.)

Every drop revealed a great number of what appeared to be isolated spherical cells, of a green color, measuring from 5μ to 6μ in diameter ($.00019$ to $.00023$ -inch.) A more careful examination showed that these cells were all connected in groups of two or more, by very delicate branching

threads, which are often difficult to distinguish. Looking over the slide very carefully we found one aggregation of these cells which showed tolerably well their mode of growth. It was then seen that a perfect family of these cells is in the form of a sphere or an ovoid mass, the connecting threads radiating from a common center and branching dichotomously. The plant is known as *Dictyosphaerium Ehrenbergianum*, fig. 8, *ed*. It is one that has puzzled us very much in the past, for we could never quite reconcile the descriptions in the books with the plant as observed. It is always described as having a mucous investment, and the cells are said to be oval. In all the specimens we have found the mucous investment had entirely disappeared, the families were consequently more or less broken up, and the cells have been quite spherical. Our figure shows the gelatinous investment, but in most cases the cells will be found as shown at fig. 8, *e*.

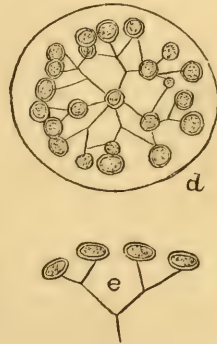


FIG. 8.—DICTYOSPHERIUM.

In this bottle was one of the largest and finest specimen of *Amæba* we ever saw. We were using a $\frac{1}{8}$ -inch objective at the time, and the *Amæba*, extending its arms in four directions, reached almost across the field of view. It was very active, and the distinction between the comparatively clear external portion, or ectosarc, and

the softer, flowing and granular internal portion, or endosarc, was unusually noticeable. It is always interesting to watch the movements of an *Amœba*. No description of its movements can enable one to form a correct idea of the appearance of the living animal. The ectosarc is first projected in the direction of movement, then the soft endosarc flows into the projected pseudopodium as though into an empty space, the large granules and foreign particles tumbling about as freely as though suspended in a watery fluid. In this way the animal moves. We ask, wherein is its vitality? How can such a mass of soft, transparent jelly manifest all the phenomena of life, voluntary movement, digestion, growth? It is a deep mystery; but there it is, under the microscope, living, moving—an elemental type of all life, the universal, essential element of every living cell. Watch it, study it carefully, think of it, follow it through its life as an *Amœba*, then upward through the history of the whole living world, trace it backward if you can, to its origin—the primal germ of life. Then found upon it a system of philosophy, and what can it be but a perfect, consistent philosophy of evolution?

All this from a single bottle of water from a pond or road-side ditch, in the dead of winter.

Correction-adjustment for Objectives.

The subject of this article has greater claims upon the attention of persons who use the microscope as a means of investigation than it has generally received. Whoever has occasion to select a microscope without knowing much about the instrument, must experience great difficulty in deciding what objectives he had better get. He will find that a $\frac{1}{4}$ -inch objec-

tive can be purchased for almost any price from \$14.00 up to \$70.00. He asks the advice of a practical microscopist, who perhaps will tell him that a good lens without an adjustment for cover-glass will serve him just as well as a more costly one with a collar adjustment. This seems satisfactory, and, having duly considered the matter from that stand-point, he goes to the optician, intending to act upon the advice thus given. But the optician tells another story. "If a lens without an adjustment is as good as one having the collar, why is it that there are so many who will pay several times as much for the latter? Here is a $\frac{1}{4}$ for \$15.00, here is one for \$35.00; they are both the best of their kind, yet my best customers prefer the \$35.00 lens. It must be it is a much better one for practical use." Now, the argument of the dealer certainly seems well-founded; and the purchaser is greatly confused by the advice of his friend and the practical knowledge of the dealer. Is it possible to throw light upon such a confusing subject? We will endeavor to give a few words of advice, partly based upon experience, and partly upon theoretical considerations. It should be said at the outset that the advice to be given in any particular case, would primarily depend upon what use is to be made of the objectives. For microscopes are sold to two classes of people: one class who use them as a means of pleasure, or recreation, and who find much satisfaction in having objectives of surpassing excellence for the exhibition of delicate test-objects; another class who use them in professional work, or in investigations in histology, biology, etc. The first-mentioned class would require all the delicacy of adjustment that the skill of the maker can devise. By saying this, we do virtually admit that the collar-adjustment is of value, and improves the quality of an objective. Unquestionably it does; but not to such an extent as would enhance the value of the objective for

the ordinary demands of original investigation. For example, why should a physician, who uses the microscope in his practice, pay \$35.00 for an objective, while the \$15.00 one will answer his purpose just as well? Why should a student in a sea-side laboratory, or in a medical college even, use anything better than the cheaper lens? As a matter of fact and experience, the adjustment for varying thicknesses of cover is useless for their purposes. The only question that remains is whether the correction objectives are not better made than the others. We are inclined to believe not. Too many people judge of the quality of an objective by its price, and for this reason there is an unfortunate opinion current that cheap American objectives are very inferior, and not worth buying. This is not true. One $\frac{1}{2}$ -objective belonging to the writer, which he uses almost exclusively in his studies, has a collar-adjustment, but probably the position of the collar is not changed once in six months for any purpose, and surely it never is in the course of observation. No doubt many others have the same experience. How many who use the microscope use the collar-adjustment except for very special kinds of work, such as the study of diatoms, for example? Very few. The German investigators have not found any difficulty in conducting very delicate examinations by means of objectives of low price; it is absurd to say that our medical students, whose requirements of a microscope are very small at the best, should buy more costly and better ones. It is demanding too great an expenditure of money for the instrument, and thus deters many a graduate from carrying on his histological or pathological studies. It is with regret that we see German and French objectives and microscopes finding their way into our college laboratories where only American instruments should be. Yet it is clear that the former are, for some reasons, used in preference;

and we have no doubt they will be, until our manufacturers make some efforts to demonstrate the equal excellence of their cheaper grades of instruments.

In touching upon the theoretical part of this subject, we are pleased to say that the grounds for a thorough and satisfactory discussion of the problem are found in the Abbe theory of microscopical vision, and have been already well set forth by Dr. L. Dippel in the *Zeitsch. für Instrumentenkunde*. We shall avail ourselves of the published article of Dr. Dippel in presenting the matter as regards the application of the collar-correction to objectives of homogeneous immersion; but first it may be desirable to refer to its advantages in the case of dry objectives of considerable angular aperture. In the case of such objectives there can be no question of the great importance of a correcting collar, for when using oblique light, only a portion of an annular zone of the objective is used, and it is important to correct the lens for the particular angle of illumination employed, even at the sacrifice of the best correction of the objective as a whole. It may be said that the importance of correction-adjustment increases with dry objectives as the angular aperture increases.

In the case of homogeneous immersion lenses, however, the advantages are not so evident. There are, indeed, certain benefits to be derived from the adjustment, but these are so slight that they cannot usually be regarded as worthy of much attention. It enables fluids of slightly different refractive power to be employed. Some makers even apply such a range of correction that the lenses will work in any fluid from water to oil of cedar. We cannot conceive how such objectives can possess any special merits, since the great range in the adjustment must, it would seem, destroy the correction of the objective for all fluids but the one for which it was especially constructed.

The collar also allows greater range in the length of the tube, and also aids in the examination of dry preparations not properly mounted. Various other advantages have been claimed for it, but they are too theoretical and infinitesimal in their effects to deserve consideration.

It has been said that the correction-collar enables the objective to be adjusted in accordance with the accommodation of the eyes of different observers, but the greatest change in the adjustment that could ever be required for such a purpose would be much less than could be made by the collar, being about 0.0001 mm.

The mechanical objections to the adjustment are not worthy of further consideration, for it has been shown that the lenses can be set sufficiently well in movable fittings. As for the additional cost, Prof. Abbe has said that the difficulty of adjusting the lenses in a fixed position at the exact distances required, within fractions of a hundredth of a mm., is so great that the cost is about the same as for a collar-adjustment.

Practically, the advantage of the collar-adjustment is quite illusory, when the microscope is applied to the study of objects the structure of which is unknown. In the observation of diatoms, when the proper appearance is known, the correction can be advantageously employed to get the most perfect image the objective is capable of giving. But in the study of histological objects, the structure of which is very delicate and not exactly determined, it is impossible to make the correction perfect by experiment, judging only from the clearness and sharpness of the image. Too much latitude is given to false or arbitrary interpretations, perhaps influenced by preconceived notions of what the appearance should be. With a fixed mounting, and corrections properly made by the maker, there can be no uncertainty as to the truthfulness of the image for the structure under examination. There is only one object

which will give the most perfect correction for a certain thickness of cover-glass, and that is the Abbe test-plate, devised to show the co-operation of all the zones of aperture. This test-plate will be fully described in a future number of this JOURNAL.

When the article by Dr. Dippel was read before the Royal Microscopical Society, of London, several of the members objected to the views set forth, among them Mr. Beck and Mr. Mayall. Mr. Crisp, Mr. Ingpen, and Dr. Edmunds, on the other hand, expressed opinions in favor of lenses without adjustment, mainly because of the acknowledged difficulty in obtaining proper correction with many objects; regarding the optician as most capable of determining the proper correction. We are inclined to regard the latter view as most capable of support from experience; and we need only cite as a single and very striking instance of the difficulty in ascertaining the proper correction, even among qualified observers, the experiments on the Podura scale, alluded to in our last number, and more fully set forth in Dr. Carpenter's book, "Revelations of the Microscope."

Notes on Diatomaceæ from Tampa Bay, Florida.

BY CHARLES STODDER.

A few weeks ago, I received a small quantity of diatoms from Mr. W. S. McNeil, of Mobile, from a depth of eight fathoms. The collection was very interesting from containing many of the species originally discovered and published by the late Prof. J. W. Bailey, and also from the condition in which they were found. Many of them appeared to have been severely acted upon by the chemicals used in cleaning them, or by the mud, or other matter in which they were found.

This condition of partial decomposition, or disintegration, produces a

great many frustules and fragments in various conditions, that afford a far better opportunity for the study of the histology, construction, and variations of this order of algæ, than many times the number of perfect frustules.

I have identified the species named below. The comparative abundance of the different forms is indicated as follows:—v. r., very rare, r., rare, c., common, v. c., very common.

Synedra chrystelina, v. r. *Campello-discus echinus*, Ehr. *C. argus*, *B. crebosis*, W. S., c. *Plagiogramma stauroptera*, Grev., r. *Terpsinoe musica*, r., (1). *Orthosira marina*, v. c. *Hyalodiscus subtilis*, B., c., (2). *Triceratium firmum*, r. *T. Favus*, v. c., (3). *T. Condicorum*, c. *Navicula didyma*, c. *N. marina*, Ralfs, c. *N. punctulata*, W. S., r. *N. lyra*, c., (5). *N. permagna*, B., c. *N. interrupta*, B., c. *N. spiculata*, Breb., r. *Pleurosigma balticum*, r., (4). *Actinocyclus*, Ehr., with 6, 7, 8, 9, 10, 12 and 16, rays, v. c. *Stauroneis aspera*, c. *Auliscus pruinosis*, B., v. c., (6). *Auliscus cælatus*, B. et Grev., r. (*Trans. Mic. Soc.*, 1863, pl. 11, fig. 5.) *Grammatophora mucilenta*, c. *Navicula longa*, Cleve, vel *A. lepidopera*, Greg.? v. r., (9). *Eupodiscus argus*, Ehr., c., (8). *E. Rogersii*, B., c. *E. radiatus*, B., v. c., (7). *Nitzschia Brightwelli*. *N. punctata*, B., v. c.

1. I have found no example of this perfect enough to positively identify the species. All the species that I have seen figured may be only varieties of *T. musica*.

2. Much variation in the fineness of the striæ.

3. This form is very common. It is smaller than usual, but variable, sides slightly convex, and processes at the angles more prominent and conspicuous than usual. I have met with a few examples of a character that I have before seen on specimens from the Atlantic coast, which appears to have been heretofore unnoticed, viz., there is a marginal row of vertical processes seen in the front view, completely surrounding the triangular

disc, like a fence. That it is so rarely seen, must be that owing to its extreme fragility it is seldom preserved in the mounting.

4. This has closer striæ than usual.

5. *N. Lyra*, very variable, mostly of the apiculate variety.

6. *Auliscus pruinosis*, B., *A. cælatus*, B.

The first of these is very abundant and very variable both in size and markings.

A. cælatus is less common. Greville compares the markings of *pruinosis* to scratches on glass with a diamond. The marks on *A. cælatus* are smooth, transparent as glass on the best examples. The scratch-like lines of Greville are the most conspicuous distinction between the two species, for, taking all the variations into consideration it is impossible to draw the line where one species begins and the other ends, though the extremes are so distinct. It would be legitimate to reduce Bailey's and Greville's (*Trans. Mic. Soc.* Vol. XI. n. s. pl. 11, figs. 1 to 8, 11, 12, 13, 18, 19, 20) to one species, for, notwithstanding the difference between figs. 1 and 22, all have a character in common, the differences being of no specific value, and so variable that it is difficult to find two alike.

7. *Eupodiscus radiatus*, B., is the most abundant form. It is very variable in size like the last, unlike that the frustules have not been affected by decomposition, but are as perfect and unchanged as if living yesterday, and from the smallest to the largest, the specific characters are identical.

8. *Eupodiscus argus*, Ehr., *E. Rogersii*, B. This form is more decomposed than any of the others, and in consequence its study has yielded more important results. It is a form that has become familiar to all who have Möller's probe- and typen-platte, and is common in many places.

Bailey figured *Eupodiscus Rogersii* and gave a figure descriptive of it, which is copied into Pritchard. Both

have a distinguishing character unlike any diatom known to me. The whole surface of the disc appears as if covered with an opaque crust, not of spicules, as represented by Mr. Slack, but of minute chrySTALLINE particles, which show nearly white by reflected light with powers of 500 to 1,000 (see *The Lens*, Jan. 1873, p. 29.)

With transmitted light the diatom is more or less opaque, with numerous translucent apertures in each aperture may be seen from 1 to 6 bright, bead-like dots or spherules. The exterior crust appears to be easily rubbed off, or dissolved by chemical action. When this is partially or uniformly done over the whole surface, it becomes *E. Rogersii*. I have authentic specimens from my friend Prof. H. L. Smith, and identical forms of this dredging. In the next stage of transformation the crust is, all but a few remnants, removed; we then have a disc of polygonal reticulation, a rough, transparent frame-work on which that crust was adherent. Through this may be seen, not always, a very hyaline disc with minute spherules. These are what were seen at first through the apertures in the opaque disc; now there is a fourth state in the histology of this plant. First, the crust; the second, *E. Rogersii* state; the third, the frame-work; fourth, this has entirely disappeared, and there is left a transparent disc with minute spherules, in lines, sparsely radiating from the centre to the margin, looking like some figures of *Coscinodiscus*. From solitary specimens of each of these conditions of *Eupodiscus Argus* these changes could never have been worked out. But I have not only seen numerous specimens in each state, but also single discs in which, on some of all conditions could be seen.

9. This is a peculiar form, narrow, elongated, resembling both Gregory's and Cleve's. I have seen no side view, and the s. r. given by those authors are unlike. Cleve notices the resemblance of his species to Gregory's.

10. *Navicula permagna*, B. is very abundant. It has been oftener decomposed than many other species in the collection, but less so than *E. argus*. The specific characters are unchanged by the action. I found but two frustules of *Coscinodiscus*, neither of which I recognized, and as I did not have Schmidt's Atlas at hand, I would not attempt to give specific names.

There is one feature of this Tampa Bay collection that often produces curious effects. Most of the valves of the discoid diatoms are of watch-glass shape. When kept in bottles of fluid, they are apt to pack themselves together like a pile of watch-glasses. This is more the case with these than I ever saw in any other collection. I have met with a *Triceratium* symmetrically placed in a disc, a disc in a *Triceratium*, and once a disc, then a *Triceratium*, and outside of that another disc. Such cases will be a puzzle to novices using insufficient power; but when the two forms vary in size and are not placed symmetrically, a little acquaintance with diatoms tells the observer what he has under the microscope. When one of them is finely marked, and both of the same size, as I found in the case of an *Auliscus* and an *Actinopticus*, there is a combination of specific lines and marks that may well perplex an expert until he recognizes the true state of things. Mr. Kitton, in the October number of the *Journal Royal Microscopical Society*, shows how a diatomist was deceived in such a case.

I have used in this study principally a Tolles $\frac{1}{8}$ immersion of 1869 with a B-eye-piece, assisted by Tolle's homogeneous $\frac{1}{8}$ and $\frac{1}{16}$ and $\frac{1}{32}$ water immersion, with a $\frac{1}{2}$ -inch eye-piece.

I will take this opportunity to dissent from the position taken by some recent writers on the microscope, that a very fine low-power objective with a high-power eye-piece, is equivalent to, or will do as good work as, a high objective with a lower power eye-piece.

All my experience goes to prove they are wrong.

Since commencing this investigation I have received from Mr. McNeil, specimens of diatoms from Pensacola and Mobile Bays, and expected to add the investigation of them to this paper; but I find the Pensacola, while containing most of the Tampa Bay species, has also many others that I need more authorities for consultation, and more time for their study.

Photography and its Value in Microscopical Investigations.

Last year the process of making photographic illustrations of microscopic objects was quite fully described and commented upon. The introduction of dry plates, all ready for exposure to the image formed by the microscope, and much more sensitive to light than the wet collodion plates used in the past, has enabled the microscopist to arrange an apparatus for photographing specimens at a very slight expense, using an ordinary kerosene lamp as the source of light. In view of these facts, it is a matter of interest to inquire whether photography affords a means of illustration or demonstration in any wise equal or superior to drawing by hand. On the one side it may be said, that a photograph is necessarily a faithful and absolutely correct representation of the object. This may be true and it may not be true. Ordinarily it is so. But somewhat depends upon the nature of the object. A transparent object does not appear the same as an object shown by reflected light, and it will not be reproduced the same upon a photographic plate. The color of the parts influences unequally the actinic power of the transmitted light. Thus, in an insect preparation, the yellow chitinous portions obstruct the most active rays of light. In order that the detail observed in these parts by the eye shall be impressed upon the sensitive plate, a rather longer

exposure is necessary than for the other parts. The dry plates, however, are far more sensitive to rays of yellow light than the wet plates heretofore commonly used, and they will give better pictures than the latter. Still, there is a loss of detail in many preparations because of the absorption of actinic rays by certain portions of the objects.

Nevertheless, photography affords a very useful method of delineating microscopic objects, and it is a very rapid method. If the apparatus is ready for use, a perfectly good photograph can be taken in five or ten minutes, by lamp-light.

On the other hand, it may be said, that the photograph only clearly represents what is in focus at one time, while the observer studies, and gets the relation between, different planes by moving the focusing screw backward and forward. Hence a pencil drawing more truthfully represents an object as it appears to the mind of the observer. This is undoubtedly a fact, and for this reason there can be no doubt of the superior value of the drawing. Yet drawings require a much longer time for execution, and their excellence partly depends upon the skill of the artist, and partly upon his familiarity with the use of the microscope.

We are inclined to believe that both the photographic and the free-hand methods of illustration or demonstration, have certain advantages of their own. In spite of the minor defects already mentioned, the photograph bears evidence upon its face of the accuracy of the observations which it is relied upon to sustain. It is to be regretted that photographic representations of objects cannot be demanded to settle disputed points. It would be an invaluable aid to Dr. Carl Heitzmann, for example, if he could photograph the blood-corpuscles in the various phases he has represented in his book, "Microscopical Morphology," on pp. 68-9 the like of which we are quite sure was

never seen—or if he could photograph the net-work so beautifully shown in the drawing on p. 309. Indeed, there is not much to be seen with a microscope that cannot be shown in a photographic print.

This brings us to another point which deserves consideration, because it is quite likely to come up before long in the discussion of fine rulings on glass. It is now universally acknowledged that the appearance of an object under a microscope is no positive indication of its structure. The same is true of the photographic representations of an object. As a rule, what the eye sees the plate will reproduce. Hence, to follow up the example already suggested, if Dr. Heitzmann should succeed in photographing the net-work, which is represented in his drawings as very minute, this would only prove that he has actually seen a net-work appearance, which we are quite willing to admit—but it would not demonstrate its existence in the structure. Nevertheless, a photograph showing the net-work would be of great value, since it would indicate whether the object was in true focus, and perhaps throw considerable light upon the methods of illumination required to demonstrate its existence. Indeed, when such a photograph is shown, the evidence concerning the existence of the net-work will rest upon a much stronger basis than mere personal assertion, and will receive more serious attention.

As concerns the subject of fine rulings, it has been proposed that photography be employed to test the capability of the microscope to resolve closer lines than theory allows. But photography alone cannot afford any evidence whatever as to the number of lines in a band. The most it can do is to facilitate the counting of the lines in an image, and thus enable the observer to compare that number with the number claimed to be ruled by the maker. In this way it can be made to do good service in refuting the extravagant claims of those who

believe they have resolved lines closer than 150,000 to an inch. The sooner the test is made the sooner will the fact, already clearly set forth in these columns, become patent, that the appearance, or the number, of lines in an image is no proof of the lined structure of an object, or of the closeness of its lines.

Perhaps photography has found its most extended use, in connection with microscopical observations, among those who are studying the schizophytes of disease. Already it has done excellent service in this field, but while it shows the forms of the minute rods and chains of spores sufficiently well for the purposes of specific identification, they are not so sharply defined in the photograph as when viewed directly in the microscope.

For a long time we have been expecting that some experiments would be undertaken with a view to perfect the processes of preparing and photographing such minute specimens. There seems to be a good field for profitable experimenting offered here. It seems not unlikely that the use of an intense but diffused, and perhaps also monochromatic, light for illuminating the objects when photographing them, would greatly improve the photographic prints.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 32 Hawley Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

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—OWING to the haste with which the January number was made up, unavoidable in changing the place of publication and perfecting new arrangements, the editor was unable to read any of the proofs. Hereafter

the JOURNAL will be regularly issued on the 15th day of every month, and if any change whatever is noticeable in the JOURNAL we trust it will be such as will commend itself to all readers.

CHANGE OF MANAGEMENT. — Last month we announced that the business management of the *Journal* had been transferred to Messrs. S. E. Cassino & Co. As there seems to be some misunderstanding about it, we wish to add that Messrs. S. E. Cassino & Co. are the publishers of the *Journal* for the year 1883, that they will fulfil all contracts for advertising previously made by the editor. The editor has relinquished the business management of the *Journal*, and placed it entirely in the hands of Messrs. Cassino & Co., who are authorized to collect payments for advertisements and subscriptions for the current year.

REMARKS ON DR. CARPENTER'S ADDRESS. — The report of Dr. W. B. Carpenter's address at Montreal last summer, which was published solely in this JOURNAL, has been reprinted and circulated in England by a member of the Manchester Microscopical Society, and is reviewed at considerable length in the January number of the *Microscopical News*. On the whole, the editor of that paper regards the views expressed by Dr. Carpenter as perfectly supported by theory and experience. In regard to the assertion that a 2-inch objective should resolve the Podura scale, the magnifying power of the ocular required for this purpose has been calculated, and it is found that an eye-piece magnifying 125 to 200 diameters, such as an E or F of Ross, would be required. Hence, a good 2-inch must bear an E-eye-piece at least. But a 1-inch with a D-eye-piece magnifies as much as a $\frac{1}{4}$ -inch as ordinarily used, yet it is said that the 1-inch so used makes a very bad quarter, while the 2-inch must

bear a still higher ocular. Consequently, while it is admitted that a 1-inch of very wide angle makes a very bad 1-inch, it does not follow that it makes a bad $\frac{1}{4}$ -inch.

Another point in reference to the 2-inch is the angular aperture it must have to resolve the Podura scale. This has been calculated from the measurement of the distances between the markings of two scales, which were found to be respectively $\frac{20}{1000}$ and $\frac{21}{1000}$ of an inch. To resolve these the minimum angle must be 207 n. a., or 24° in air.

Then follows an interesting comparison of the prices of objectives of different kinds, in which the writer makes a distinction between "a good set" of English objectives for £10 or £12, and "a set of good" English objectives at over £36.

STANDARD SIZES FOR OCULARS AND SUBSTAGES. — The great convenience of uniformity in the size of oculars and substages is so patent that any discussion of the subject is quite unnecessary. A committee of the Royal Microscopical Society of London, reported some time ago in favor of two standard gauges for eye-pieces, the larger being a size much used in stands made in England, the smaller conforming to the gauge of many continental stands. The sizes recommended are respectively 1.35 and 0.92 of an inch, external diameter. The larger size is designated as No. 1 gauge, the smaller as No. 2. It is to be hoped that our American makers will adopt the same sizes.

The gauge recommended for substages is 1.5 of an inch, internal diameter.

ROTIFER AND PHILODINA. — In the course of a conversation with Mr. Balen a short time ago, he referred to the resemblance between *Rotifer* and *Philodina*, and said that the latter was such a common animal that it was doubtless often taken for *Rotifer vul-*

garis, without proper examination. The two genera are, however, easily distinguished by the position of the eyes. Mr. Balen states that in *Rotifer* the eyes are on the proboscis, very far forward, while in *Philodina* they are situated behind the calca, or cervical. It is well to bear this distinction in mind, although it is one distinctly set forth in all books treating of the Infusoria.

METHOD OF IMBEDDING.—The following method of imbedding in gum, seems to have much to commend it for delicate objects of which sections are to be cut, although it requires some time to prepare the specimens for cutting. The great advantage it seems to possess is that the tissues become slowly but thoroughly penetrated with the mepium.

Pure gum arabic is dissolved in water, forming a syrupy liquid. A portion of this is poured into a watch-glass, so as not to quite fill it, and six or ten drops of glycerin are added. The specimens to be cut are placed in the fluid, and then the solution is allowed to dry, which may require several days. The gum becomes cartilaginous, when it may be cut into pieces enclosing the specimens. These pieces are taken out and allowed to dry still more. They will never become hard, owing to the glycerin, and may be kept indefinitely. The drying may be hastened by artificial heat, or by exposure to the sun. The best sections seem to be obtained when the pieces have had a week to dry. The medium is transparent, so that the objects may be examined with the microscope before cutting, and the sections made at exactly the points desired.

It will be remembered that a method of imbedding proposed long ago was to place the object in a solution of gum until saturated with it, then partially dry it until hard enough to be plunged into alcohol. The alcohol

removes the water from the gum and hardens it. Whether the new method above described is better in all cases than this more expeditious one we do not know, but in cases where it is not desirable to use alcohol, or when the object is very delicate, we have no doubt it is preferable.

METHODS OF MICROSCOPICAL WORK.

—The methods of preserving, staining and mounting objects in use at the zoölogical station at Naples, have already been published in several journals, but as some of them are of special interest to our readers, we briefly allude to them, taking the information from the *Journal Royal Mic. Society*.

Picrosulphuric acid, a fluid introduced by Kleinenberg, is used for killing specimens. It kills quickly, rapidly replaces the sea-water, and may be directly replaced by alcohol, and does not harden. It is useful for embryos of vertebrates, fishes, and crustacea. It is composed of a saturated solution of picric acid in water, 100 parts, by measure, concentrated sulphuric acid, 2 parts. Filter, and dilute with three times its bulk of water.

Alcohol is a valuable agent for killing, but it is not generally used in the right way. The best way is to add the alcohol to the water that contains the specimen—an annelid, for example—slowly. The animal then remains extended and supple.

Osmic acid is apt to blacken the objects stained in it by continuing to act after removal from the acid. Objects thus rendered worthless may be restored by placing them in 70 per cent. alcohol, with some crystals of potassic chlorate, adding strong muriatic acid until chlorine is liberated which bleaches the object.

Corrosive sublimate in concentrated solution is used for killing planarians, corals, hydroids, echinoderms, minute crustacea, etc.

NOTES.

—The death is announced of Mr. Andrew Pritchard, at the age of 78 years, author of Pritchard's "Infusoria," a work which, since the date of its publication in 1841 has been highly valued by microscopists throughout the world. The work rapidly increased in size with successive editions, for forty years ago very little was known about the infusoria, and improvements in the microscope were just beginning to be made. The fourth edition was published in the year 1861, and is now very difficult to obtain, being held as high as \$30 for worn copies.

—We are indebted to Messrs. Bausch & Lomb for a fine cabinet photograph of their works at Rochester. This firm has developed an extensive trade in microscopes and objectives, through the excellence of their work, and careful attention to the demands of customers.

—Those who are using dry plates in photographing with the microscope will find a good and cheap developer, recently proposed by Mr. H. J. Newton, of this city, an excellent one.

Solution A.—Washing soda, 500 grains; water, 10 ounces.

Solution B.—Oxalic acid, 30 grains; pyrogallic acid, 20 grains; ammonium bromide, 10 grains; water, 10 ounces.

These solutions will keep. For use, mix equal parts of each together. We copy the formula from the *Photographic Times*.

—The twelfth edition of Messrs. R. & J. Beck's "Illustrated Catalogue of Microscopes and Optical Instruments" has recently come to hand. This Catalogue contains such a great number of illustrations of microscopical accessories, that it serves the purpose of a dictionary to the beginner, or even for those of longer experience who do not use many accessories. Among other articles we notice a description of the Sorby microspectroscope, as made by the Messrs. Beck, and also an illustration and explanation of the more recently-devised Sorby binocular microspectroscope.

—The excellent Microscopical Journal published by Mr. Bogue, in London, heretofore known as *The Northern Microscopist*, begins its third volume under a new name, more in keeping with its comprehensive character. It is now *The Microscopical News and Northern*

Microscopist. Under the able editorial management of Mr. George E. Davis, the magazine has become one of our best English exchanges. We observe one change which the editor believes "will be heartily welcomed" by the subscribers. This is precisely the change that was announced by this JOURNAL one year ago,—the condensation of the reports of meetings of societies.

—Dr. Charles Shepard, of Grand Rapids, Mich., has favored us with two beautiful preparations of mineral crystals, mounted in brass cells, which are not only very inexpensive, but also very neat and convenient. The cells we have are turned from $\frac{3}{8}$ -inch and $\frac{1}{4}$ -inch brass tubing, and are about $\frac{1}{4}$ -inch in depth. The upper edge is rounded off, and a bit of cork forms the bottom of the cell. The specimens are mounted on sealing-wax dropped upon the cork. No covers are used. The cells can be attached to glass slips, but they take up less room, and are quite as convenient when used as they are. We can commend this method for mounting mineral crystals; the specimens of auriferous pyrites and crystallized copper are very fine.

—In July last year, Mr. H. H. Davison inquired through the JOURNAL whether the *Stephanoceros* was abundant in this country. Mr. A. D. Balen has been making some inquiries, and he states that the only places where it has been found, so far as he can learn, besides two ponds in New Jersey in which he has found single specimens, are the following:—Mr. E. B. Grove has found it in Roger's Glen, Oneida Co., N. Y., the Rev. W. R. Cross at Camden, Me., and Mr. C. F. Park, near Poughkeepsie, N. Y.

A new method of silvering glass for reflectors has been devised by Prof. Palmieri, and described in *Les Mondes*, without giving the exact proportions of the ingredients used however. He has found that silver is reduced from an ammonical solution by glycerin, the action being hastened by heat and the addition of a few drops of caustic potash and alcohol or ether. The coating is said to be exceedingly brilliant and perfect. Although the best proportions are still to be determined by experiment, the method may be useful to microscopists who wish to resilver small pieces of apparatus, mirrors, etc. One secret of success will be in having the glass surface to be silvered perfectly clean.

CORRESPONDENCE.

BREAKAGE OF SLIDES IN THE MAIL.

TO THE EDITOR.—Cannot some of your readers suggest the probable cause of the breakage of many slides in the mails, and propose some method for their safe transmission, thus promoting a freer exchange of microscopical preparations among preparers, with a consequent increase and diffusion of microscopical knowledge? So great is the percentage of breakages as in some instances to amount almost to a prohibition of exchanges. Some of the slide-boxes are as much crushed in the mails as if run over by the wheels of a baggage truck or wagon. Others have received a shivering blow upon one corner. Now ordinary mail packages are limited to four pounds in weight; but public documents passing through the mails are not restricted within any given limits, and some of them, single volumes, weigh thirteen pounds each. Glass slides can scarcely be expected to withstand such missiles, when the mail bags are hurled from the mail wagons upon stone sidewalks, or from postal cars to the platform.

Double boxes are no safeguard, for while the boxes receive not so much as a scar, the opener finds only a mass of broken glass. Does not some over-zealous post-office official open the boxes, as he has a perfect right to do, discover writing on the labels, search for contraband communications thereon, and in his disgust at the fruitlessness of his superfluous zeal, replace the slides with cells in contact, and packing half left out? The Micro-cabinet Postal Club have devised a kind of box which renders the transmission of slides through the mails quite possible; but such boxes are too expensive for the private exchanger, particularly when the boxes are not returned, and the construction of each box means the preparation of just so many less slides. The profits upon microscopical goods are excessive enough, but if in addition to this, the percentage of breakages of slides in transit by mail increases in the ratio it has done for the past year, exchanges must soon be confined not to preparers of good work, but to possessors of purses plethoric enough to bear the draft of express charges upon every slide sent out.

M. A. B.

LONGMEADOW, Mass.

[No one can doubt that the breakage of slides in the mails is quite unnecessary. We hear no complaints about it in England, where there are no senseless restrictions upon exchanges of specimens of natural history, such as we have to contend with here. Our own experience is that slides can be sent to certain places without being damaged, while on other routes the boxes are unmercifully smashed. We can send to Ohio or California without fear of damage, but two successive packages sent to Albany, packed precisely like others sent elsewhere, were unnecessarily smashed somewhere on the way. We do not pretend to know why this should be so, but we do know that any package reasonably well put up and sent by registered mail, will reach its destination uninjured. It is, therefore, quite unnecessary that slides should be injured in the mails to the extent mentioned by our correspondent.—ED.]

MICROSCOPICAL SOCIETIES.

The SYRACUSE Society recently held a meeting at which an interesting address was delivered by Dr. E. R. Maxson, entitled "The Microscopy of Nutrition." The address is too long for reproduction here; but the concluding words will indicate its general nature:—

"Thus the microscope aids us in understanding the various changes produced in food undergoing the digestive and nutritive processes, as well as enables us to examine the various secretions which either aid in, or are accessory to, a healthy performance of these processes. It aids us to discover not only the elements of the waste products in a state of health, but also the various abnormal waste products in diseased conditions, constituting important diagnostic indications of health, and of the various diseased conditions, as well as enabling us to comprehend more clearly the nutritive process.

At a meeting of the FAIRFIELD (Iowa) Microscopical Club, held Nov. 17th, the following officers were elected: Prof. Albert McCalla, President; Dr. T. James, Vice-president; J. F. Clarke, Secretary; Dr. R. H. Hufford, Treasurer.

At a meeting of the ROCHESTER ACADEMY OF SCIENCES, held Jan. 8th, Mr. H.

F. Atwood alluded to some of the entomostraca in the water of Hemlock Lake as follows:—

The attention of the members is called to the number of *Canthocamptus minutus*, now in the water of Hemlock Lake. While I have occasionally noticed them in filterings of our water-supply, they have never seemed so plenty as during the last week or two. In a filtering made yesterday they constituted the bulk of my find. The *Canthocamptus minutus* is, to my mind, one of the most beautiful and interesting of the entomostraca. Smaller than the *Cyclops*, and much more trimly built, it has the same number of segments in the body, but, unlike the *Cyclops*, there is no clearly-defined division between the thorax and abdomen, there being a gradual taper from the head to the posterior segment. From the latter two long and two short bristles project, the former, in many instances, being as long as the entire animal. The antennæ are much shorter than in *Cyclops* or *Diaptomi*, consisting of only seven segments or articulations in the male, and nine in the female. The females, at this time of the year, carry a single sac full of eggs, which are quite embryonic as yet. In February we will have ample opportunity to study the young.

At a meeting of the NEW YORK Society, held February 2d, a paper was read on "Correction-Adjustment for Homogeneous Immersion Objectives," which is published in another column. Mr. C. Van Brunt then spoke a few words about *Amphipleura pellucida*. He stated that he had recently visited Geneva, where he saw the *A. pellucida* resolved by Mr. Spencer with an unfinished $\frac{1}{10}$ -objective, a flour-barrel being used for a table, and the mirror-bar of the microscope being so loose that it had to be propped up with a stick. Daylight was used for illumination, and the lines were remarkably distinct throughout the length of the frustule. Mr. Spencer and Prof. Hamilton Smith both seem to think the new lens will, when completed, surpass anything yet constructed for resolutions. The lens will soon be the property of the speaker. Prof. Smith has been cultivating *A. pellucida* in a vial, and the diatoms grow vigorously, and collect upon the sides of the vial away from the light.

The entire frustule was represented on the black-board as it appears under the microscope, showing the outline of the valve and the two raphe, but no line in-

dicating the line of junction between the two valves can be seen. Owing to the absence of such a line, it has been thought the cross section of the frustule must be triangular—the diatom being composed of three valves.

The speaker alluded to the great difficulty of removing air from certain diatoms, such as the *Isthmia* and others. He has found the following method to succeed perfectly well: The frustules are dried on the cover-glass, which is then placed on a slide, diatoms up, and plain balsam is dropped upon them. By heat the balsam is caused to flow around the diatoms, but it does not replace all the air within them. By alternately heating the balsam up to the boiling point and then cooling it, two or three times, all the air can be expelled.

President Braman made a few remarks about the structure of diatoms, and their classification.

Mr. Balen showed some fine specimens of pond-life, including some of the flagellate infusoria. He mentioned particularly some of the family *Astasiaæ*, and said they seemed to differ from *Englenæ* only in the absence of color. Mr. Hyatt referred to his observations on the change of color of the *Englenæ* from bright-green to a brilliant red.

Mr. Britton called attention to a deposit of diatoms recently discovered on Staten Island, at Clove Lake, and exhibited a specimen. Mr. Van Brunt identified one of the forms as *Stephanodiscus*.

Mr. Mead showed two slides of *Bacillus tuberculosus*, prepared by Ehrlich's method, one of which had been treated with ether to remove any fatty matter that might be present.

NOTICES OF BOOKS.

The Naturalist's Assistant: A Handbook for the Collector and Student. With a Bibliography of fifteen hundred works necessary for the systematic zoologist. By J. S. Kingsley, Boston: S. E. Cassino, Publisher, 1882. (Small 8vo., pp. 228. Price \$1.50.)

This is a book of which we can well appreciate the value, since it is just such a work as we have felt the need of in collecting. We can recall many an interesting specimen which we would have been glad to preserve, had we known the proper

method of preparing it, but not knowing this, they were thrown away. Just such useful and practical information is given in this book. It is true that the collector is likely to know very well how to preserve the particular objects for which he is searching, but while looking for objects of one kind, who has not found those of a different kind which he knows would interest his friends, or that he would like to preserve even as mere curiosities? The book before us is written for the naturalist and is useful for the professional man, and also for the amateur, or novice. It contains many valuable suggestions about collecting and preserving specimens of all kinds, mammals, birds, nests and eggs, reptiles, fishes, skeletons, insects, larvæ, etc., with instructions for mounting them, suggestions for laboratory arrangements and work, useful recipes, and lastly, a long list of references to books and articles to "aid the student in arranging and identifying his collections."

Microscopical Morphology of the Animal Body in Health and Disease. By C. Heitzmann, M. D. Late Lecturer on Morbid Anatomy at the University of Vienna, Austria. With 380 original engravings. New York: J. H. Vail & Co. 1883. (Large 8vo. pp. 847. Price \$7.00).

This is a large, elegant volume, well printed and profusely illustrated. It treats of the different tissues of the body in a manner certainly calculated to arrest the attention of the student of histology. There is little opportunity left for doubt when the author endeavors to demonstrate a favorite hypothesis. His language is positive, his convictions are strong. That there is much valuable and useful information in the book we cannot doubt, yet what there is we find so interspersed with teachings which must be regarded as erroneous and based upon imperfect observations, that we should hesitate to commend the work as a text-book for a beginner; for it is impossible to distinguish, by the language used, between facts that are established, and those which are still, to say the least, unverified.

The book contains reprinted articles from other authors, some of which are worthy of preservation in such a readily accessible form; others might better have been left out and forgotten. It also

includes many reproductions from articles previously published by the author.

As would naturally be expected, the "bioplsson" doctrine is fully set forth, and the cell-theory is discarded as unworthy of further attention. The space at our disposal does not admit of any lengthy abstracts from the pages before us, such as we would like to give, but a fair idea of the convincing nature of the language used may be formed by the short quotations here given:—

"Last year I published my observations on pus-corpuscles, which enable me, from the amount of living matter contained in an individual corpuscle, to say . . . whether the person from whom the pus comes is healthy and strong, or weakened by chronic disease, as tuberculosis." (p. 32.)

"Thus I have arrived at a point of perfection which allows me to tell the constitution of a person without knowing anything of his former life." (p. 60.)

All of which is unmitigated bosh!

There is another delectable story (page 61) in which it is said that a young physician—but a very gullible one, we should think—proposed to abandon his intention of marrying his cousin on account of the nervousness revealed by his blood-corpuscles under Dr. Heitzmann's microscope!

Exchanges.

FOSSIL DIATOMS from Franzensbad, Bohemia, and Celle, Hanover, in exchange for good material of any kind, mounted or unmounted. T. C. Brinnböck, 17 Simmering, near Vienna, Austria.

WANTED.—Mounted slides of *Palmogloia*, *Protococcus*, *Volvox*, Stained Bacteria, *Trichina*, or sections of coal or limestone, in exchange for vegetable preparations. James E. Humphrey, North Weymouth, Mass.

ANY Microscopist having good, prepared material, particularly diatoms, to spare in exchange for diatoms *in situ*, untreated recent or fossil diatoms, marine algae, ferns, skins of sharks and eels, and many other objects, please communicate with M. A. Booth, Longmeadow, Mass.

FOR SLIDES of Diatoms from the Wabash & Erie Canal at Ft. Wayne, send any well-mounted slide to H. C. Tresselt, Fort Wayne, Ind.

WANTED.—Insects, or parts of insects well mounted, for other well-mounted objects, including rare seeds, pollens, epidermal organs of plants, etc., etc. George Timmins, Troy, N. Y.

FOR EXCHANGE.—Mounted or unmounted, the beautiful seeds of the insectivorous plant, *Drosera longifolia*. Rev. E. A. Perry, Palmer, Mass.

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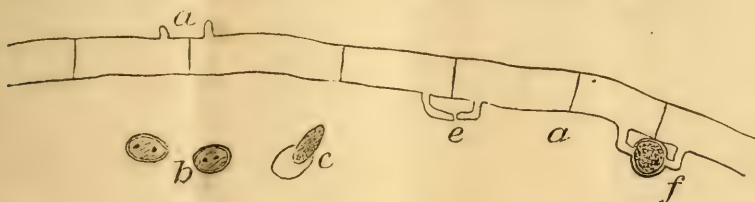


FIG. 9.—*a*, A FILAMENT IN FRUIT; *b*, RESTING SPORES; *c*, SPORE RUPTURED AND CELL ESCAPING.

An Alga in an Aquarium.

A species of fresh-water alga, growing in my aquarium the past season, has interested me very much by its peculiar method of fruiting. Conjugation is effected between two adjoining cells of the same filament; on the side of each cell, near the end, appears a small protuberance (fig. 9, *a*); these grow and gradually curve toward each other until their ends meet (*e*), when they fuse together and enlarge to a circular, or rather oval, cavity, (*f*) into which the contents of the two cells flow, and a spore is formed. The filaments then decay and the spores, now enclosed in a brown, cellulose envelope, are to be found at the bottom of the jar.

After a few months of rest the spore begins to swell slightly, and nuclei—usually two—can be seen through the brown, outer coating. After a time this is ruptured and there issues from the cellulose envelope a transparent cell filled with green endochrome; this single cell gradually grows and subdivides, forming long, green filaments.

E. L. CHEESEMAN.

KNOWLESVILLE, N. Y.

[The alga described by our correspondent is a species of *Mesocarpus*; the specific name could not be determined from the description and the drawing sent. Rabenhorst distinguishes between *Mesocarpus*, which fruits by the conjugation of cells of different filaments forming the spores between them, (not as in *Spirogyra*, *Zygnema*, etc., in the cells of one of the filaments) and *Pleurocarpus*, which conjugates as illustrated in fig. 9. The two modes of conjugation are respectively designated as scaliform, or ladder-like, and lateral. Kirchner has grouped the two genera under one genus, *Mesocarpus*, Hass., and distinguishes between species with ladder-like, and those with lateral conjugation. — Ed.]

Improved Filtering Reagent Bottle.

BY C. E. HANAMAN, F. R. M. S.

Having recently made some improvement in the "Filtering Wash-bottle" described before the "Section of Histology and Microscopy" of the A. A. A. S. at Montreal last August, I append a description and drawing of the apparatus, which I think will be

found useful by histologists and others who are in the habit of using staining-fluids.

It is a matter of every-day experience with those who employ the microscope in histological research, that however careful they may be to filter their reagents before beginning the day's work, particles of foreign matter are apt to appear ere long in the various solutions employed, and, not unfrequently, become attached to the most interesting portions of valuable preparations, marring their beauty, and sometimes detracting from their

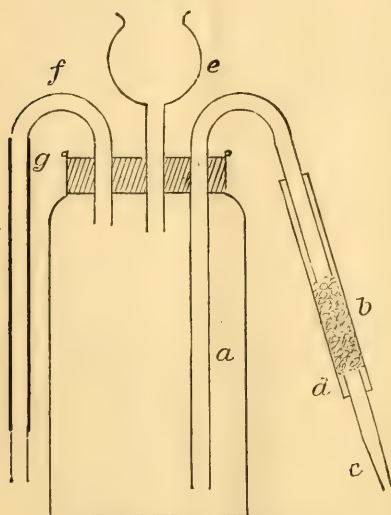


FIG. 10.—FILTERING WASH-BOTTLE.

value. The usual forms of filters of paper and cotton, are not as convenient as one could wish, and it was with a view to the production of a simple apparatus, which would deliver, perfectly filtered, any quantity of a staining-fluid, or other reagent, from a single drop to a dishful, that I devised, about two years ago, the bottle here described. A wide-mouth bottle, of convenient size, is fitted with a cork through which three glass-tubes are passed; one of which (fig. 10, *a*) reaches nearly to the bottom of the bottle, while the other two tubes extend only just below the cork.

The long tube is curved above the cork, and at a point just beyond the curve, there is attached to it a short piece of tubing (*b*) of twice the diameter of the first. The lower end of this larger tube (at *d*) is also fitted with a cork, through which passes a short piece of small tubing, which is slightly contracted at its distal end. Over the cork and open end of this short delivery tube, a piece of fine muslin (*d*) is stretched, and the space (*b*) in the large tube, is filled with a loosely packed plug of absorbent cotton, forming a very effectual filter. The second tube ends above the cork in a "thistle-bulb" funnel (*e*), the opening in which, is formed into a neck of sufficient length to enable one to cork it securely. Through this thistle-top tube the reagent may be readily poured from a dish or other vessel. The third tube (*g*) is bent over the side of the bottle and a piece of rubber-tubing is attached, which may end either in a short glass mouth-piece or an atomizer-bulb, as the student may elect. In case the bulb is used it will be found necessary to loosen the cork in the funnel-tube (*e*) when a sufficient quantity of the contents has been expelled, in order to release the pressure and stop the flow.

This bottle differs from the one described at Montreal, only in the use of the thistle-top tube, and common bottle, in place of the more expensive three-neck or Wolfe's-bottle. The thistle-top tubes may be purchased for about fifteen cents apiece, while the Wolfe's bottle would cost fifty cents or more.

Further, the thistle-funnel permits a solution to be readily poured into it from a dish while the necks of the Wolfe's-bottle are so small that the use of a funnel is necessary, except when the solution is poured from a spout or bottle-neck. Stains may thus be returned to the bottle and used over and over again, being perfectly filtered each time they pass through the plug of cotton. A gentle breath at the mouth-piece, or a slight compression

of the bulb, expells a single drop, while by blowing steadily for a moment, or rapidly working the bulb, a dishful of the reagent is obtained.

When the plug of cotton becomes foul, which will not be for a long time, even with Hematoxylin stain, it may be replaced by a fresh one by simply uncorking the lower end (*d*) of the large tube, pulling out the old plug with a pair of forceps and inserting a fresh one. The cotton should be but loosely packed to work easily. If the contracted end of the delivery tube becomes clogged through long disuse, it may be freed with a pin or fine wire, and the first dishful of the reagent returned to the bottle, when it will be found that the succeeding dishful will be perfectly filtered.

Troy, N. Y.

Distortion Produced by Camera Lucidas.*

A short time ago Mr. Grunow requested me to examine one of his new camera lucidas† with care, and for that purpose he very kindly adapted one of his instruments to fit the ocular of my stand. The results of my examination, and the comparison between the Grunow, and the Zeiss "double prism" camera lucidas are, in brief, as follows:—

The Grunow form gives a clear image projected on the paper entirely free from the base of the microscope, while in the Zeiss form, as is well known, only a portion of the field of view is available for drawing,—in the case of my own microscope about one-half.

When the light upon both paper and object is adjusted with the utmost care, the pencil-point seems to be as clearly seen in one instrument as in the other. Mr. Grunow claims

some superiority in this respect for his form of construction over all others. On the other hand, greater care in adjusting the strength of the light on object and paper is necessary with the Grunow than with the Zeiss, and a relatively stronger light may be thrown upon the object when using the latter, which is a decided advantage, as more detail can then be seen while drawing. To explain the reason for this, I will briefly allude to the principles upon which the two cameras are constructed. It will be remembered from the published description of the Grunow instrument,* that in this form the light from the object passes through two prisms with their faces together, forming a block of glass with parallel sides. The object is seen, therefore, with an intensity of illumination which cannot be varied except by moving the mirror. In drawing with a camera lucida, some parts of an object can be distinctly seen and readily followed with a pencil, while other parts, being either too delicate to be seen distinctly, or too black to allow the pencil-point to be followed over them, can only be perfectly drawn by changing the relative illumination of object and paper. To some extent it is possible to do this with the Grunow instrument by means of the mirror.

In the Zeiss instrument no glass intervenes between the eye and the object. The prisms are only employed to give a view of the pencil and paper. The edge of the prism nearest the eye bisects the cone of rays coming from the ocular, or rather the pupil of the eye receives a portion of its light from the object by looking over the edge of the prism down the tube, while another portion comes from the paper and is reflected into the eye by the prism. Consequently, the relative brightness of the paper and the object as seen, can be varied within certain limits by moving the eye over the edge of the prism so as

* Remarks made before the New York Microscopical Society at the meeting of March 2d, 1883.

† See this JOURNAL, Vol. iii, p. 201.

* Loc. cit.

to either take in a larger bundle of rays from the object, which would increase the relative brightness of the latter, or a larger bundle from the paper, when the relative brightness of the object would be reduced. In this way it is possible to follow details of an object very accurately with the pencil. Consequently, it is not necessary to adjust the light so perfectly when using the Zeiss instrument, and if the illumination of the object be quite strong, the eye can still follow the pencil-point. Indeed, it is sometimes desirable to make the light on

ple reflecting disk over the ocular which would throw an image of pencil and paper into the eye, the object being seen over the edge of the disk, would be a type of the best possible form.

A few words now concerning the distortion produced by the two forms mentioned. A stage-micrometer ruled in hundredths of an inch, and a $\frac{2}{3}$ inch objective, were used.

The Grunow instrument was first used, the inclination of the stand being, in two different experiments, 30° and 40° from the vertical.

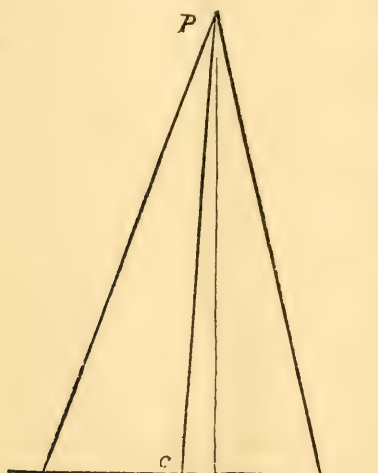


FIG. 11.—ZEISS CAMERA LUCIDA.

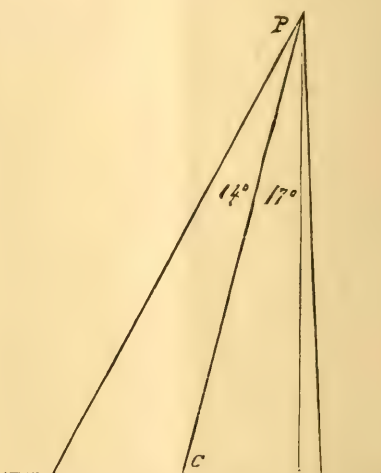


FIG. 12.—GRUNOW CAMERA LUCIDA.

the object very strong, for then many details can be drawn which are not visible when the pencil is also seen, but by properly placing and moving the eye, the pencil can be seen just behind the sharply defined border of the bright image, and made to follow after it, in a manner not easy to describe.

Owing to the readiness with which the eye equalizes the illumination of paper and object in camera lucidas in which the light is divided in this way, I am inclined to regard them as theoretically the most perfect form, and, speaking from theory and not from practice, I should think a sim-

1. Inclination 30° , lines of the micrometer running vertically across the field.

The diameter of the field projected upon the paper was, approximately, seven inches. The distance between the lines, near the margin of the field nearest the microscope on the paper, was 1.03 inches; at the margin furthest from the stand it was 1.15 inches. Hence the difference in magnification at the two extremes of the field was 12 diameters.

2. Inclination 40° . Repeating the same experiment under this inclination, the results were respectively 95 and 100 diameters; difference, 5.

Zeiss camera lucida, inclination about 13° . As only half the field was projected on the paper, the lines had to be extended across to seven inches to make the results comparable with those of the Grunow.

3. Lines vertical. Magnification at the extremes of a field of seven inches diameter, respectively 104 and 113; difference, 9. This is greater than with the Grunow, but it will be shown that the actual distortion of vertical lines produced by this camera is only 4.5 at the greatest.

4. Lines horizontal. Owing to the small field visible, only two contiguous spaces were measured, showing an increase from the centre outward of 3 diameters.

The above figures should not be considered as absolutely accurate. They were not made with a view to publication, and are only approximately correct—sufficiently so to illustrate the subject.

The Grunow instrument shows the entire field of view on the paper. Measuring from the middle of the surface of the prism to the margins of the field on the paper, we find the angle of view to be 16.5° , the margin nearest the microscope being only 3° from the vertical, the center being 17° from that margin, and 14° from the opposite side. Hence, the distortion produced diminishes slightly toward the center from either side; but the real difference from side to side, is shown by our results.

The Zeiss instrument only gives half the field; but the centre is almost directly beneath the centre of the face of the prism, 3.5° from the vertical, hence the distortion is about equal on either side of the centre, and does not increase from one side to the other as in Mr. Grunow's instrument.

The two figures, 11 and 12, show the differences between the two camera lucidas at a glance; p represents the face of the prism in the two cases, c the centre of the field of view on the paper. Fig. 11 shows the Zeiss instrument, fig. 12 the Grunow. It will be understood

by simple inspection of the two figures, that while the distortion produced by the Zeiss instrument extends outward from the centre of the field of view (fig. 11), that of the Grunow increases from one side of the field to the other (fig. 12). Such being the facts, a camera lucida should be used with great discretion in making drawings for purposes of measurement—as, for example, in drawing blood-corpuscles for microscopical expert testimony.

I present these facts for what they are worth. I do not think the distortion produced is of very great consequence, in most cases, nor do I see how it can be absolutely eliminated from camera lucidas. It is only when large objects are to be drawn, or, as already intimated, when measurements are to be made, that the distortion deserves serious attention. For my own work it is not worthy of notice. Still, I am surprised to find it so considerable. The microscope should be placed at the proper angle for least distortion at all times, when the camera lucidas is to be used, as these experiments clearly show, and this is best determined by a stage-micrometer in the manner indicated.

The Visibility of Ruled Lines.

At a meeting of the Boston Scientific Society, held on the evening of Jan. 10th, Prof. W. A. Rogers read a paper on fine ruling, a considerable portion of which has already been given in this JOURNAL. A few interesting points, however, deserve the attention of microscopists. Prof. Rogers stated that he had ruled bands of lines in which the lines were so fine and delicate that they could not be seen with a microscope, although their spacing was much within the power of the microscope to resolve. Yet he was assured of the existence of the lines. The evidence in support of this assertion was of three kinds: The pressure of the diamond upon the glass was sufficient to

produce a cut; the diamond produced a peculiar singing sound while moving over the surface, which is always indicative that it is working well; and finally, the lines become visible when filled with fine graphite.

There is a limit beyond which lines cannot be satisfactorily filled with graphite. It is difficult to fill lines finer than about $\frac{800}{1000}$ or $\frac{700}{1000}$ of an inch.

A most surprising result of some of the experiments of Prof. Rogers, is that the unaided eye can discern not only single lines that cannot be seen with a microscope, but that it can detect errors which the microscope will

A Home-made Substage Condenser.

It is with me very much as it is with many lovers of the microscope, being situated so that I have had to make many of my accessories, and I contribute this description of my substage condenser, believing it to be an adjustment that will give excellent results if properly made. It is for low-power objectives, and the cut, fig. 13, shows the objective in position at *A*. The end *B* has a carefully cut thread for focussing the objective, operated by a milled head.

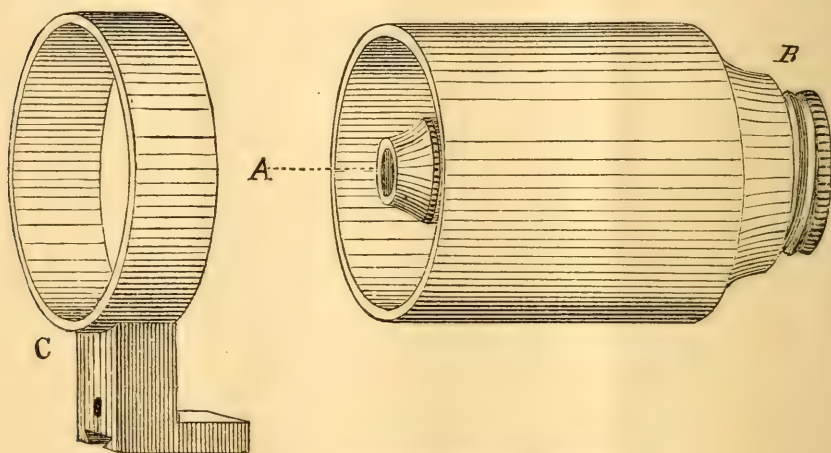


FIG. 13.—A HOME-MADE SUBSTAGE CONDENSER.

not show. Thus, he has a bar upon which lines are distinctly visible to the unaided eye, and, although an objective of low power will show them, one of high power will not. But even errors or imperfections in ruling which cannot be seen or measured with the microscope, may reveal themselves to the eye by a peculiar waviness of the image. He attributes the failure of the objective to show the lines, as mentioned above, to the inability to illuminate the lines with light of the exact angle of incidence required, and the proper angle of illumination he thinks deserves more careful attention.

If the condenser is found to be eccentric when in focus, it may be rotated by the milled head, and adjusted by sliding the adapter forward or back in the substage (*C*) to adjust the focus; but if it is well-made this will seldom be necessary except in work with high-powers. When working with my $\frac{1}{2}$ -inch, I use my $\frac{1}{2}$ -inch as condenser; when using a higher power I use the $\frac{3}{4}$ -inch as condenser, etc.

With a Swift nose-piece I can center my objective to the condenser, thereby doing away with the necessity of focussing by the slide. D. FOLSOM.
CHICOPEE, Mass.

A Third Corpuscle in the Blood.

[The following article is an editorial review-notice from the pen of Dr. J. B. Marvin, which was printed in the *Louisville Medical News*. — ED.]

In November, 1878, Dr. Richard Norris read a paper before the Birmingham Philosophical Society, claiming to have discovered a third or invisible corpuscle in the blood, which could be rendered visible by a peculiar method of manipulation, viz., packing and changing the refractive index of the serum. The freshly-drawn blood was mixed with a saturated saline solution, and then placed in contact with the edge of a cover-glass and slide tightly bound together. By capillary attraction the corpuscles were drawn between the glasses, till they reached a spot where they could not pass owing to the close contact of the glasses. The serum drains off, and the corpuscles "pack" together. By mixing carmine with a saturated solution of salt, the invisible corpuscles can be stained. Dr. Norris claims that normal blood teems and swarms with these colorless bodies. These corpuscles, Dr. Morris claimed, are young, immature bodies, and a new and ingenious theory of blood-formation was offered.

This paper was widely commented upon. The London *Medical Record* for January, 1880, contained an elaborate criticism of Dr. Norris's paper, written by Mrs. Ernest Hart. The critic, in a most logical and convincing manner, demonstrated that the methods of Dr. Norris would cause the appearance he described as nominally existing. She proved that the excessive pressure to which the corpuscles were submitted by the packing process would cause them to lose their homoglobin, which tinted the serum, changing its refractive index, and rendering visible corpuscles which had lost their coloring matter.

Another striking experiment was made by Mrs. Hart. Blood from the same subject, at the same sitting, was

mixed, respectively with a five-per-cent. solution of sodium sulphate and a saturated solution of sodium chloride, and the corpuscles counted by means of a hematometer. The mean counting gave in the sodium-sulphate solution 4,920,000 corpuscles per cubic millimeter, and in the saturated salt-solution 3,260,000, showing that about one-third of the corpuscles had been rendered invisible by the salt solution.

A few months ago Dr. Norris published a book, "The Physiology and Pathology of the Blood," in which he gives his views of the morphology of the third corpuscle and describes his methods of demonstrating it. The book is illustrated with one hundred and ninety-six photographs, and gives fully the views and deductions of Dr. Norris. The first part of this book is a republication of his original essay, but modified in many important respects to conform to the criticisms of Mrs. Hart. The author is very ingenious in devising methods for demonstrating his "third corpuscle." He now relies upon the following processes: (1) Absolute alcohol; (2) a two-per-cent. solution of osmic acid; (3) a seventy-five-per-cent solution of sodium chloride; (4) a soluble colloid; (5) the packing when fresh blood is seen under their flexible mica covers.

Mrs. Hart, in her last criticism, claims that upon reading Dr. Norris's republished paper, often altered in an exactly opposite sense to the original without explanation, and his reply to her first criticism upon the original text, published now for the first time in the same volume with the altered text, it is sometimes difficult to discover to what her strictures allude. She examines Dr. Norris's new methods seriatim, and to our mind proves beyond the shadow of a doubt that the invisible corpuscle is the artificial production of the methods used, and is nothing else than a red corpuscle decolorized out of the body, and is not an actual living corpuscle of the blood.

Mrs. Hart's paper is a model criticism. Dr. Norris's theory in itself is beautiful and complete, and assumes to explain some of the darkest secrets of physiology; but it rests entirely on the demonstration of the existence of the invisible corpuscle as a normal element in the blood. Since this fact has been so skilfully disproved by Mrs. Hart, the entire theory falls to the ground.

The Reticulate Structure of Living Matter ("Bioplason").*

The living matter of plants and animals, from the lowest protophyte to the highest form of animal life, is, so far as our knowledge extends, identical. It is variously named protoplasm, bioplasm, sarcodæ, and, not having a sufficient number of names, still another has been applied to it — bioplason — and a new hypothesis of the structure of living matter, termed the "bioplason theory," has recently been put forward, and upheld in this country mainly by Drs. Carl Heitzmann and Louis Elsberg. It is this so-called theory, which at the most is merely an hypothesis, accepted by a very few persons, that I desire to speak of this evening.

I may say at the outset, that it is my intention to speak very pointedly concerning this hypothesis. For a long time it has been taught to medical students and practicing physicians; and occasional articles have been published in medical and dental journals, describing the structure of bioplason, according to the observations of those who support it; but it has always seemed that more accurate and scientific evidence must be brought forward before it would receive general attention. Yet not much has been said against it. This is, no doubt, partly because the errors involved in it are of a nature very unpleasant to

refute, since in so doing one must, of necessity, question either the skill or the integrity of the observers.

In bringing the subject before you this evening, I shall be obliged to point out what I believe to be the errors of observation of those who are responsible for the bioplason doctrine. I shall endeavor to do this without reserve, for the question before us is one of fact; and an assertion made in the name of science before this Academy, must bear the most rigid examination, or be expunged from the records of scientific truths.

Although I have written a few words upon the subject to read before you, it is not upon these, or upon any argument, that I rely to uphold me in the position I have assumed in this matter. For either the observations of those gentlemen are capable of verification and demonstration to this audience, or else they are not true. If a small fraction of what we are told concerning the structures described is true, there is not a person in this audience to whom the appearance in question cannot be shown by the aid of the microscope. Therefore I shall rely upon ocular proof to show that there is no reticulum in the blood-cells.

We are accustomed to hear more or less rambling talk about the difficulties in microscopical examinations, the great amount of training of hand and eye that is required to use the instrument. The microscope, like every other instrument of research, requires to be manipulated by a person of experience to yield trustworthy and the most perfect results. Yet there is a vast difference between the ability to manipulate it, and the ability to see what it reveals. Perhaps only a small proportion of this audience could use the instrument fairly well, yet I doubt if there is one person here who could not see the most minute details of any object, after the proper adjustments have been made. . . .

I am not an histologist, and I do

* Abstract of an article read before the New York Academy of Sciences, by R. Hitchcock, Feb. 5th, 1883.

not presume to criticise this bioplason doctrine as extended by its supporters over the field of histological study. I can only treat it from the stand-point of one familiar with microscopical work. I declare the foundation of the whole theory unsound. The reticulate structure of protoplasm is either a creation of the observer's mind, or a false appearance due to faulty adjustments of the microscope. If the reticulum is a myth, the whole theory fails.

We may consistently confine the discussion to three objects; viz., the *Amœba*, and the red and the white blood-corpuscles. As those who have heard Dr. Elsberg's remarks before the Academy know very well, the theory is, essentially, that all living tissues are constituted of a fine net-work of very contractile, living matter, with inert matter filling the meshes. It is not necessary to explain the theory more at length, for the reason that the existence of such a net-work, readily seen by the aid of a microscope, forms the foundation of every observation in support of it. Moreover, as the reticulum is said to be clearly visible in all living matter, we have only to prove either that it does or does not exist in the *Amœba*, or in a white blood-corpuscle, to sustain, or to utterly refute the theory.

I propose to demonstrate to this audience, that there is absolutely no trace of such a net-work in a blood-corpuscle. I propose, if possible, to show you the blood-corpuscles under some of the finest object-glasses that have ever been produced in America or Europe, highly magnified and sharply defined. But, lest any person should still doubt his or her ability to see all that the microscope would show to an experienced observer, I will say that according to the reiterated declarations of the two gentlemen already mentioned, the reticulum is to be seen "with great ease,"—that it has only to be looked for and it will be found. I shall also show you an object that is not easily seen, in order that those

who doubt their ability to see what it is necessary to see, may test their sight. It is the lines on the silicious shell of a diatom, known as *Amphipleura pellucida*. To show these lines requires the best objectives and very careful management of the light. . . . The fine, transverse lines are about $\frac{1}{95000}$ of an inch apart, and it is these lines that Mr. Mead has kindly consented to show you this evening. Any person who can see the lines in the microscope, can certainly see a reticulum which is conceded to be easily seen in a blood-corpuscle, if such a reticulum exists.

In a review-notice of Dr. Heitzmann's new book, published in the *New England Journal of Dentistry*, we find the following passage:—

"We have not been able to appreciate the objections of some microscopists to the reticulum, as claimed to have been seen by Dr. Heitzmann. If all the finely looking pictures are deceptions, never observed by unbiassed observers, we would rather not read books any longer; but fortunately they are too plain to admit of any doubt. If Dr. Carl Heitzmann alone claimed to have seen the reticulum, we might doubt, but the host of others who have seen it no longer permits us reasonably to doubt the facts." This seems, at first glance, to be a very rational and proper view of the subject. Probably no one doubts that Dr. Heitzmann does see, and can show to any one, an appearance of a reticulum in a corpuscle. We cannot conceive that so many intelligent persons could be led to declare they had seen it, unless they had seen what, at least, might be a reticulum, and what they believe is such.

Further on I will indicate some of the fallacies to be guarded against in microscopical work. I will only declare now, that when the object-glass is properly corrected and focussed, no reticulum whatever can be seen. In other words, the apparent reticulation which Dr. Heitzmann shows is, undoubtedly, the result of faulty obser-

vation of some kind ; but probably the faults are not of a kind that a student or inexperienced microscopist would be able to detect, or to point out with any assurance. The writer of the abstract quoted, need not grow despondent because the fine figures in the book are likely to be proven deceptions. The errors perpetuated in books have greatly hindered the advance of knowledge and the discovery of truth. Yet knowledge is advancing in spite of them.

Another course of reasoning, which is exceedingly weak, has been supposed to give support to the idea of reticulated structure. It is said that the movements of a homogeneous jelly, such as protoplasm has been described to be, would be impossible — that some kind of reticulated structure is necessary to enable us to explain its power of movement. The absurdity and weakness of this kind of argument are too apparent to deserve further notice. At present it is merely a question of fact whether there is a reticulum or not. After its existence has been demonstrated it will be time enough to theorize about how it enables us to understand the phenomena of life.

The reticulum is supposed to explain the movement of living matter ; movement is due to contractility, the contractility resides in the nodes and connecting threads of the net-work ; the extension or contraction of the net-work explains the movement of the *Amœba* and the blood-cell. It is an ingenious, mechanical explanation of a mystery that has puzzled the scientific world for ages. All the motions of life are due to the contraction and expansion of a reticulate structure, which is common to all living things. How easily all the observed facts are explained ! What an admirable machine the *Amœba* is ! Perhaps somebody will ask, by what means the reticulum itself is enabled to extend and contract. I am not aware that any effort has yet been made to solve this problem. Enough, that the movements we

see are explained upon mechanical principles. Like the thousands of persons who are satisfied to understand mesmerism as animal magnetism, and strange phenomena as due to electricity in the air, these gentlemen present, in the name of science, an explanation that does not explain.

The sources of error in microscopical observation are : 1. Improper illumination. 2. Imperfect correction of the objectives. 3. Incorrect focussing. The first source of error does not concern us in the case under consideration, for no special niceties of illumination are required. The second is of more consequence ; but, in order to eliminate it from my own observations, I have used objectives which were either adjusted by the makers and set in fixed mountings, so that their corrections could not be changed, or else I have adjusted the lenses myself by the use of suitable objects, so that their correction was as perfect as possible. Finally, errors of focussing alone remain as the only ones which cannot be absolutely eliminated. Yet these, in the special objects of study, the *Amœba* and the blood-cells, are of no consequence whatever ; for no experienced observer can be in doubt as to the exact focus for a white blood-corpuscle.

A few words now about the appearance of blood-corpuscles when highly magnified. The red corpuscles, when examined in the serum, are double concave disks. When lying flat, in the focus of a good objective, they appear to be quite homogeneous in structure ; the central portion of the disk, owing to the concave shape, appearing slightly darker than the rest. I am not aware that it is claimed that a reticulum can be seen in the red corpuscles under such circumstances. To demonstrate the net-work it is necessary to use some reagent, and a saturated solution of potassic bichromate, diluted with about an equal volume of water, is recommended for the purpose. The addition of such a solution to fresh blood produces a great change

in the appearance of the corpuscles. They become granular, and some of them undergo slow changes of form, budding, etc., as Dr. Heitzmann has described in his book, recently published. When the corpuscles begin to become granular, there is a time when they present an appearance of reticulation. But careful observation with high-powers fails to show any connecting net-work. There is nothing but a breaking up of the contents into separate granules; and as the action of the reagent continues the granules become more distinct, until they can be very clearly defined by a good objective. I have such a preparation to show you this evening.

It is not convenient to show a white corpuscle of the blood this evening, but a pus-corpuscle will serve us just as well. It is asserted that the reticulum can be seen in these corpuscles without any preliminary treatment with reagents. The true appearance of a white corpuscle is like a colorless, transparent disc, distinctly granular, but there is no net-work about it.

The *Amœba* consists of a simple mass of protoplasm, containing granules. Under a very high power very minute granules can be detected in the clearest portions of the *amœba*'s substance. But there is no reticulum whatever to be seen. I hope to be able to show you an *amœba* this evening, so that you may judge for yourselves whether it is granular or reticulated.

It has been suggested that Dr. Heitzmann may show an appearance of a reticulum where no reticulum exists. It should always be considered that errors of interpretation are very easily made in microscopical work. Sometimes it is not possible to interpret the image in the microscope with any degree of certainty. In this case, however, there need be no uncertainty. The *Amœba* or the blood-corpuscles do not introduce these sources of error. What they may be made to show under special

conditions of illumination and wrong adjustment of the objective, must remain a matter of conjecture until Dr. Heitzmann demonstrates what he has seen so that all in this audience may see it. It appears, therefore, from what has been said, that the net-work is described in granular structures only. It is seen in white blood-cells, which are granular, in the *Amœba*, which is granular, but not in the red blood-corpuscles until after they are made granular by the action of chemicals.

It is a fact well known to observers with the microscope, that any body regularly marked with fine and close dots, can be made to appear as though covered with fine, continuous lines. The dots merge into each other, and form lines in the image. Thus, in the diatom *Pleurosigma angulatum*, an inferior objective will show the markings as fine, distinct lines, but a better lens will resolve the lines into rows of dots, a fact familiar to every microscopist. It is doubtless owing to this, that the granular structure of protoplasm has been taken for a reticulum, but I cannot for a moment regard such an error of interpretation, which is still persisted in beyond all reason, as pardonable in a person of experience. It is a fact that there is not a microscopist of authority in the country who has been able to see the reticulum described by Dr. Heitzmann. Without an exception, all who have looked for it have declared their failure to find it, although following Dr. Heitzmann's instructions in every particular.

I believe the strongest, and the most convincing argument against this bioplasm doctrine, is the fact that the reticulum which these gentlemen declare is so readily observed, has hitherto entirely escaped the notice of the best histologists in the world. Dr. Heitzmann has used these words: "Take a drop of pus, fresh, without adding anything; and you will see the wonderful structure in each pus-corpuscle *with great ease.*"

I will ask if it is reasonable to suppose that a structure that can be seen "with great ease" could have been overlooked by such men as Beale, Balfour, Carpenter, Frey, Bütschli, and a host of, other equally competent observers, and reserved for an individual of to-day to discover. Yet this is what Dr. Heitzmann declares he has discovered, and upon this discovery he has built up a totally new and comprehensive theory of the structure, not only of living matter, but of the whole living world, connecting all the different tissues of the animal and vegetable body through this reticulum, and utterly discarding the cell-doctrine, which has rendered such excellent service to science for thirty years. To an experienced microscopist, the idea seems preposterous. The objects most familiar to the histologist and pathologist, coming almost daily under the eye of the physician who uses the microscope in his practice, are now declared to possess a distinctly reticulate structure, never before even dreamed of.

Another convincing demonstration of the glaring inaccuracies of the observations of these gentlemen has been well made by Dr. L. Curtis in his "Reply to Dr. Heitzmann," published last year. (Abstract read.)

Testing Microscope Objectives.*

BY DR. ALLEN Y. MOORE.

With all the microscopical literature we have, it is surprising to see how little attention objectives have received, and, at the same time nearly every work on the subject tells us that the objective is the most important part of the entire instrument. That this is a fact, I think no person will deny, and if the objective be otherwise than perfect, a knowledge of its imperfections will help the observer by giving him an idea of how

far his instrument may be considered trustworthy.

All first-class objectives in which the angular aperture exceeds 75° or 80° in air, should have a correcting collar; and although it makes less difference with the lower powers, the higher ones should be so constructed that the collar moves the back systems of lenses.

Bad centering and bad form are conditions which are inexcusable. By bad centering is meant, that the centres of the lenses are not in a straight line. By bad form is meant that the curves of the lenses are not segments of true spheres. Either of these conditions may be detected by what is known as the artificial star. This is nothing more than a very small globule of mercury upon which a strong light is thrown.

If such a globule be placed in the centre of the field and carefully focussed, a bright spot, which is the image of the source of light, will be seen. If the tube be now racked up or down, so as to throw the globule considerably out of focus, it will be seen that the bright spot expands and becomes a large circle of light. If the lenses be truly formed and correctly centered the edge of this circle, or expansion of light, will be true and even, but in case the lenses are not in a straight line, the circle of light, or coma as it is more frequently called, will not be perfectly round but will seem to bulge more on one side than on the other. Bad form is shown by an irregularity of the outline of the coma, and the shape of the coma will indicate the shape of the curved surfaces of the lenses.

Chromatic and spherical aberration next deserve attention. Chromatic aberration is that condition in which the white light, after having been decomposed by the refracting surfaces of the crown lenses, is not properly recomposed by the proper action of the flints. When an objective brings the violet light to a focus before the red, it is said to be chro-

*Read before the Griffith Club of Microscopy, of Detroit, February 6th, 1883.

matically undercorrected; if the red rays meet sooner than the violet, it is said to be overcorrected.

With the lower powers the artificial star is about the best test for determining this condition. With the glass now used by opticians for the construction of objectives, perfect achromatism has never been attained; there being at best a secondary spectrum caused by the unequal dispersion of the various parts of the primary spectra of the flint and crown glass lenses. These colors are a pale green and pale violet. If a well-corrected objective be focussed upon the mercury globule, and then brought without and again within the focal point, it will be seen that the circle of light has a colored border, and that when the globule is without the focus this border is of a pale green color, when within it a pale violet. These colors indicate the best chromatic correction, and any variation will show itself by more or less change in the color. If undercorrection be present it is indicated by the green taking on a bluish cast, or, if very much undercorrected, a distinct violet is to be seen. In the place of the proper violet—that is when within the focus—a reddish violet, or even a brilliant red, is seen. Overcorrection is indicated when in the place of the green, a yellowish-green, brilliant yellow, or orange is seen; and in the place of the proper violet, a blue border is seen. This applies, not only to the mercury globule when used as stated, but to almost any opaque border of an object. With the higher powers, a very convenient way is to use a well-marked diatom, or, what in most cases is still better, a strongly marked podura scale. In any such objects as these, the dots or spines appear violet and the interspace green when the chromatic correction is right; and in the case of under or over correction these colors give way to the colors already mentioned as occurring with the artificial star.

The correction of spherical aberration is more important than that of color. By spherical aberration is meant that the rays of light which pass through different zones of the objective do not unite in one point in the eye-piece. If the peripheral rays meet before the central ones, the objective is said to be spherically undercorrected, while if the reverse be the case, overcorrection is present. With the artificial star the presence of spherical aberration is shown by the coma, or circle of light, expanding unequally when the globule is placed within the focus, or the same distance beyond the focus. Should the greater expansion of the coma take place when the distance between the objective and globule is increased, the objective will be undercorrected, but when the greater expansion is within the focus, overcorrected.

I have here this evening a one-inch objective with which, by the aid of the artificial star, I shall practically illustrate the appearances seen with a well-corrected glass. The workmanship of this lens is superb, and, although of moderate angular aperture, it is much better in definition and resolution than many lenses of much wider angle. By the aid of the back system of a cheap English one-fourth-inch objective, I shall illustrate the irregularity of outline of the coma, which indicates a want of true form or curves, of the lenses.

Angle of aperture is of great importance. By this is meant the angular breadth of the cone of light received from the object by the objective. This is to be determined by direct measurement. As convenient a method as any, is by using a stand which has a graduated rotating base, or graduated swinging substage bar. The objective should be put upon the stand and accurately focussed, the stand being in a horizontal position. A lamp is then placed several feet distant, and, by turning the stand upon the base, the aperture is ascertained, the light

being allowed to divide the field equally at each extreme of the angle. In case the measurement is to be made by the aid of the substage bar, this may be made to carry a small candle or lamp, which should be diaphragmed to a narrow slit. The measurement, as before stated, should be made from the point at which the light bisects the field. When it is desired to measure balsam aperture, or the angle of the rays in Canada balsam, it is necessary to use the proper immersion fluid, and to have a hemispherical lens placed under the object (the object, of course, being balsam mounted) whose centre of curvature is in the plane of the object. The readings upon the base or substage bar then indicate the angle within the hemispherical lens; and if this be of the same glass as the front lens of the objective, the true glass angle, or, as it is more commonly called, the balsam angle, becomes known.

I think it may not be unjust to say that many of the objectives of our best makers, will fall considerably short of the aperture claimed for them. A recent $\frac{1}{8}$ for which an angle of 130° in balsam, was claimed, only measured 125° ; a very fine $\frac{1}{10}$ for which 140° was claimed, only gave 116° ; and a $\frac{1}{16}$ claimed to have 105° , only gave 97° .

An objective may have a very wide angle of aperture and still be inferior to that of another objective of less angle. In such cases the trouble is generally due to a want of proper correction for chromatic and spherical aberration. In measuring aperture it is always well to select some test-object which shall be more or less difficult to resolve with the objective to be measured. It should then be focussed and carefully watched as the stand or mirror bar is turned, until the very best resolution is attained. By increasing the obliquity of the light it may then be seen whether the extreme rays which traverse the periphery of the objec-

tive are really of any use. For example, in the $\frac{1}{8}$ already mentioned the light will enter the objective at 125° , but the light which forms the image only enters at 120° ; hence the objective is no better than one properly corrected having 120° .

Flatness of field and penetration are two qualities of which I can say but little. Many of the best objectives have a very flat field, but I have never yet seen one in which the definition was really good to the extreme edge. It is easily determined by examining any flat, well-marked object, such as a section of echinus spine with the lower powers, and a slide of evenly spread blood-corpuscles with the higher ones.

Working distance is of especial value in high powers. It is the distance of the object from the front lens when in focus. It can only be ascertained by actual measurement. For this purpose a scale and vernier on the ways of the body are very desirable, but I have never yet seen a micrometer screw sufficiently good to correctly measure the working distance of the higher powers. The best way of measuring the greatest working distance is by having a number of cover glasses of various thicknesses, accurately measured, and see which is the thickest that the objective can be made to focus through, using the ten-inch body. It will be found that the actual distance between the object and the objective will increase with an increase in thickness of cover-glass or the density of immersion fluid.

The magnifying power of the objective is a matter well worth knowing. Many objectives are underrated; for example, a recent $\frac{1}{10}$ which I measured only gave 84 diameters as its greatest power, while another $\frac{1}{16}$ gave the unusual power of 120 diameters, thereby being a true $\frac{1}{12}$.

The correct point from which to measure the power, is the optical centre, but as this changes with every change of immersion fluid or length

of body, it is not practicable, hence the front surface of the front lens is generally taken as the standard, and the image is measured at a distance of 10 inches from this point. The best way of doing this is by placing a micrometer on the stage and a piece of finely ground glass at the end of the body instead of the eye-piece. The distance of the ground glass from the front of the objective should be ten inches. If the micrometer be now illuminated by very intense lamp light, or in the case of the higher powers by sunlight, and carefully focussed, the image of the lines will be seen on the ground glass. Their distance apart may then be dotted on the ground glass and then carefully measured. If the distance apart of the dots upon the ground glass be now divided by the real distance of the lines on the micrometer, the linear amplification will be the result.

The power of the eye-piece may now be determined from that of the objective. The eye-piece should be placed in the tube, with its field-lens in the case of a negative eye-piece and its focal point in the case of a positive eye-piece, at a distance of ten inches from the front lens of the objective. The power of the microscope should now be taken at ten inches with the camera-lucida in the usual way. The power of the microscope, divided by the previously determined power of the objective, will give the power of the eye-piece in diameters.

The Cause of Tubercle.*

I have been asked to say a few words concerning the *Bacillus tuberculosis*. The subject has already been so ably brought before us by Dr. Schöney, that I shall not take up much time this evening. First I wish to briefly allude to the specimen of

Bacillus on the slide to be shown by Mr. Mead. I have examined it with care, but I have failed to observe the peculiar split or forked end which is said by the original discoverer, Dr. Koch, to be characteristic of the *Bacillus*. I am inclined to doubt if the ends of the *Bacillus* are really split. On the slide of Mr. Mead I have seen an appearance of cleft ends which was purely an illusion caused by the inclined position of some of the *Bacilli* with reference to the vertical axis of the microscope. Slight changes of the focus produce a false image of the end of each rod, which appears like a branch or fork running out from the true image. I regret not to have the original article by Dr. Koch, to assist in identifying the bacillus on Mr. Mead's slide, but Dr. Schöney has stated the length of the rods of Koch's *Bacillus* to be $\frac{1}{12100}$ of an inch. These measure about $\frac{1}{8700}$ of an inch, and are, therefore, very much longer than Dr. Koch's species.

The experiments of Dr. Koch to prove that the *Bacillus* is the true cause of tubercular disease have been regarded as conclusive by many observers, but there is still a large number of physicians who doubt not only the conclusive nature of the experiments, but even the contagiousness of the disease itself.

Clinical experience affords much opportunity for differences of opinion concerning this subject. The impression that consumption is a contagious disease was held by Galen, and since his time it has always had more or less support by the medical fraternity. Yet it is universally conceded that not all persons are readily affected by the disease. Dr. Sternberg has made a few experiments by inoculating animals with tubercular matter. Three out of six experiments resulted in the development of tubercles and the characteristic *Bacillus*. Dr. Janeway, of this city, has given some valuable information on this subject in an article on the "Possible Contagion of Phthisis," published in the *Archives of*

* Read Feb. 16th before the New York Microscopical Society.

Medicine. In this article he cites the case of a gentleman who was affected with tubercular disease, communicating the malady to three pet dogs in succession, and these, with a number of other cases, seem to leave no room for doubt of the contagiousness of the disease.

Dr. H. Formad, of Philadelphia, has, however, taken a vigorous stand against Dr. Koch's conclusions. He has written an able article for the *Philadelphia Medical Times* expressing his views regarding the cause of tubercular disease, and he does not admit that any bacterial organism takes part in the production or course of the disease. He explains the development of tubercle as due to a peculiar condition of serous membranes, which may be either peculiar to the individual, or induced by injury to normal and healthy membranes. He maintains it is proved that no infective agent is required to produce tuberculosis. While he does not deny that Koch's *Bacillus* may be capable of producing the disease, he asserts that there are at present no proofs either for or against it. The fact that the bacilli are abundant in tubercle-tissue but disappear when the latter undergoes cheesy degeneration and softening, is brought forward as an argument against the conclusions of Dr. Koch. Dr. Formad also declares that he has been unable to discover that the *Bacillus tuberculosis* is distinguished from any other bacilli as regards the action of staining fluids.

ERRATA.

Errata to the article by Mr. Charles Stodder in the February number:—

- Page 30. In title, for Diatomacæ read Diatomacæe.
- Page 31. First column:—
- Line 12. For *Campello-discus* Ehr., read *Campello-discus*, Ehr.=
- Line 15. After *musica* insert (?).
- Line 24. For *Actinocyclus* read *Actinoptycus*.
- Line 26. For *pruinosis* read *pruinusos*.
- Line 29. For *mucilenta* read *macilenta*.
- Line 30. For *Amphipleura* read *Amphiprora*.
- Page 31. Second Column:—
- Line 9. For *pruinosis* read *pruinusos*.
- Line 30. For 20 read 22.
- Page 32. First column:—
- Line 5. For spicules read spherules.
- Line 3 from bottom. For s.r. read s.v.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 32 Hawley Street, Boston, Mass.

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A MOIST-CHAMBER FOR CULTIVATION. — Our experience with various kinds of growing-slides has not been very satisfactory. Very likely all the different forms proposed have some merits; but none of them, as far as our experience goes, have proved convenient and entirely successful. The most satisfactory arrangement that we have used for keeping growing objects alive, and in a healthy condition for long periods of time, is that employed by Drs. Dallinger and Drysdale in their studies of minute monads. In that apparatus the slides could be taken directly from the microscope, and placed in a moist chamber, where the organisms would remain in a perfectly healthy condition for any length of time.

Having occasion to watch the development of some cells of algæ not long ago, and having no moist chamber at hand, two methods were devised, and immediately put in practice. The first was practically the method commonly adopted for cultivating fungi. A small salt-cellar was inverted in a dish of water to serve as a support for the specimens, and a tumbler was inverted over this. The specimens were placed on glass slips, made by cutting an ordinary slide across the middle, and covered with thin glass. Small slips were used, because two of them could be supported on the salt-cellar under the tumbler.

The other plan, however, we prefer. A piece of glass, four inches square, is placed upon a support so that it is about on a level with the top of a dish to hold water — an ice-cream saucer is what we used. A piece of blotting

paper is then placed on the glass, and the edge allowed to dip into the water. Objects to be examined are placed on large cover-glasses, and either covered with a smaller cover, or left exposed. These cover-glasses are laid upon the blotting paper and covered with watch-glasses. A single large watch-glass of $3\frac{1}{2}$ inches diameter may be used, or a number of small ones, one for each specimen. Objects can be kept fresh and moist in this way, with far less trouble than by any other method we have tried.

THE MOVEMENT OF DIATOMS.—Mr. Jabez Hogg recently addressed a communication to the Société Belge de Microscopie giving his views concerning the cause of the motions of diatoms, a *résumé* of which is published in the *Bulletin*. The author believes that the movement is caused by very contractile, prehensile organs, which are alternately projected and retracted through openings of the valves near the median nodule.

Dr. Van Ermengem commented upon the article by Mr. Hogg, and stated that he had tried many experiments with staining fluids, osmic acid, absolute alcohol, etc., in the hope of discovering the cause of the movement, using the best objectives and illuminating apparatus, but he had failed to discover any apparent cause of the motion in any case.

PLANTS IN WATER AT HIGH TEMPERATURES.—In a hot spring in Pueblo Valley, Humboldt Co., Nevada, diatoms in great abundance were collected by a Dr. Blake, living in water at a temperature of 163° F. More than fifty species were described from the spring, mostly identical with species found in infusorial earth in Utah. Associated with the diatoms was some red alga.

In one of the hot springs at the California geysers, at a temperature

of 198° F. he found also two kinds of *Conserva*, one species "resembling *Hydrococcus Bischoffii*, but larger; the other a filament with globular enlargements at intervals." In another spring, oscillaria were found, growing at a temperature of 174° .

AN EVENING WITH AMPHIPLEURA.—One evening last month, at the invitation of Mr. C. Van Brunt, a few interested friends met at his residence in New York to examine the new $\frac{1}{16}$ -inch Spencer objective, which he described before the New York Microscopical Society a few evenings before. The test-object used was the *A. pellucida* mounted dry, and the lens was compared with several others by Tolles and Zeiss. The exhibition of the dry *A. pellucida* given on that occasion was exceedingly fine. The objectives used for comparison were two one-sixths and an eighth by Tolles, and two-eighths and a twelfth by Zeiss, and the aggregate value of the seven fine objectives used, was calculated at about \$640.00, an amount which indicates the high appreciation, on the part of the owners, of the finest products of the optician's skill.

The $\frac{1}{16}$ is, undoubtedly, one of the finest lenses for resolution ever yet produced. The only objectives that compared favorably with it were the sixths of Tolles. Between the Tolles $\frac{1}{6}$ and the Spencer $\frac{1}{16}$, there was scarcely any appreciable difference; in fact, the difference was so slight on the dry-mounted frustule, that we prefer to withhold any expression of preference for one or the other until the lenses are tested upon a balsam-mounted shell. Both the $\frac{1}{6}$ and the $\frac{1}{16}$ were tested with oculars varying from a C. Huyghenian up to a $\frac{1}{4}$ -inch solid, and, we doubt not, either of them would have borne a $\frac{1}{8}$ -inch solid ocular, had one been at hand. We consider that by the production of the new $\frac{1}{16}$, Mr. Spencer has demonstrated his ability, which many who have been acquainted with his work have long known, to

make objectives fully equal to the best, which he sells at a lower price than is charged by some of his competitors. But it cannot be said that this latest production has proved so vastly superior to anything previously seen in New York, to justify the great expectations aroused by the letter to Mr. Van Brunt which he read at the meeting of the Society. To say that it is equal to the best, is sufficient, and justly deserved, praise. The price of the new $\frac{1}{16}$, with a collar adjustment, is \$75.00; without a collar it is sold for \$10.00 less.

NOTES.

— Dr. George M. Sternberg has written a work, soon to be published, on "Photomicrographs and How to Make them," which will be illustrated with seventeen heliotype plates, taken from his best negatives. We look forward to the publication of the work with much interest.

— Mr. J. S. Kingsley describes the following method of imbedding, in *Scientific and Literary Gossip*:—

The substance to be imbedded is hardened after any of the usual methods and placed, from alcohol into turpentine and then transferred to a saturated solution of paraffin in turpentine, the same as in other methods of paraffin embedding. Here is where the novelty comes in. The specimen is removed from the mixture and the superfluous fluid removed by means of blotting paper and then placed on the end of a cylinder of paraffin (or paraffin and vaselin). A bit of stout iron wire is now heated in the flame of a spirit lamp, and with it a hole is melted in the end of the cylinder and the specimen then pushed into the melted paraffin and placed in any desired position. The advantages of the method are: the quickness with which it may be performed, for from the time when the operation is begun until sections can be cut is not over three minutes, while the melting of so small an amount of paraffin prevents any injury to tissues by overheating. In embedding solid bodies, a slight variation sometimes results in the saving of more time. The specimen may be embedded directly from alcohol without the inter-

vening turpentine and then when the section is cut it readily separates from the shaving of paraffin without the use of turpentine to dissolve it. This, of course, applies to solid bodies without cavities or irregular outline.

— The first two numbers, of the *Bulletin of the Buffalo Naturalists' Field Club*, bound in a pamphlet of 48 pages, has recently come to hand. The numbers are to be issued bi-monthly, each number to consist of 24 pages. It is edited by Prof. Kellicott, Eugene Fish and Mary B. Moody, and the subscription price is \$1.00 per year.

— Dr. M. Schulgin recommends for imbedding a mixture of paraffin (fusing point 55°) with a proper quantity of ceresin. The latter is a substance similar to wax but rather harder and tougher. The thin cuts are not brittle, as when paraffin alone is used. A small quantity of vaselin will soften the mass if that is desirable.

— The sixth volume of the *Annales of the Microscopical Society of Belgium* has been published. It contains two memoirs; one by Mr. Julien Deby on the microscopical appearances of the valves of diatoms—the second article by the author on the subject—treating of the genus *Amphora*; the other by M. A. Renard is a lithological description of specimens of the reefs (*recifs*) of the island of Saint Paul, in the Atlantic, obtained by the "Challenger" expedition. The latter is a long and valuable contribution with three figures of sections of the rock. The remainder of the volume is taken up with the *Bulletins des Séances*.

CORRESPONDENCE.

TO THE EDITOR.—In the January number of the JOURNAL, inquiry is made, in course of a review of another article, as to the possibility of finding *Chara* and *Nitella* growing in midwinter. For five years past I have secured an abundance of *Nitella* from a springy pool on the marsh north of Ithaca. I use it for class (laboratory) work, and it is in excellent condition showing the apical cell, cell-formation, and motile protoplasm, as well as in summer time. I have no doubt it might be found growing, or rather the *Charas* might, in the deeper waters of our

lake, but not in the shallows where they would be exposed to actual freezing.

The springy pools referred to are rarely, or never, frozen over. *Spirogyra* I procure in the same way, for winter study. Of course, it is not in fruit.

WILLIAM R. DUDLEY.

MOTION OF DIATOMS.

TO THE EDITOR.—Inasmuch as all efforts to find some *outside* means of movement have failed, is it not very probable if not almost certain that their movements are produced within the frustule? The front view of naviculas, and of all elongated forms having a central nodule, usually show a division of the vegetable contents into two or four parts, having a main central alley between them running both lengthwise and crosswise. Currents seem to be produced by some means, through these central alleys, and water is forced out of the porous frustule at the ends or sides as through a sieve, inasmuch as the cross lines of diatoms are merely attached globules of siliceous matter with spaces between. These globules of siliceous matter, being so close together, prevent a clear vision of the interior part of the frustule but it seems probable that vibratile cilia line the surface of the vegetable matter within, and these beating in unison cause the water to flow in one direction or another as they more or less unite in their action. Could a fresh frustule be broken open, I believe the surface of the vegetable matter within would show this presumed ciliated arrangement.

J. M. ADAMS.

[Our correspondent, like many others, finding no satisfactory solution of this problem through observation, resorts to speculation concerning it. We must caution the reader that it is not yet known whether the frustules are perforated or not, as will be seen from an article soon to be published in these columns. As for the presence of cilia within the diatoms, we have no more reason to expect to find cilia there than in any other cells in which the movement of protoplasm has been observed—as in desmids, or in the cells of higher water-plants, for example. Moreover, diatoms are not the only plants which move without visible cause. The desmids, for instance, move with vigor, and they are not enclosed in a siliceous shell which obstructs examination of the interior. In young desmids especially, the cyclosis can be examined with satisfaction by high-powers. Look-

ing over the algaë, we find that the oscillaria are quite as remarkable in their movement as the diatoms, and we cannot yet explain it, and in the animal kingdom the jregarinæ also move without giving the least indication of how the motion is produced. It is a subject for still further investigation, and we have no doubt that with good objectives, supplemented by staining fluids properly applied, the cause of the movements will soon be discovered.—ED.

MICROSCOPICAL SOCIETIES.

At the meeting of the NEW YORK Society held February 16th, Mr. C. Van Brunt spoke on the subject "Desmidiaceæ."

The most common forms of desmids, he said, belong to the genera *Closterium* and *Cosmarium*. The desmids differ from diatoms in the absence of siliceous walls, and the endochrome of diatoms is distinguished by its color and the presence of iron. In the desmids a constant circulation of granules can be observed just within the cell-wall at the sides and at the ends. The desmids have a power of movement, which is still unexplained. They cannot be preserved by mounting them in any way yet tried by the speaker. They keep for some time, but after a few years the barest outline of their form remains, and finally even this disappears. The principal methods of multiplication of desmids,—by simple division and by the formation of sporangia—were briefly described.

In the discussion which followed, Mr. Van Brunt stated that since he had obtained very fine lenses he had endeavored to discover the cause of movement, but had failed to do so. The movement is slow, then there is a sudden jerk. He had found great difficulty in drawing desmids with a camera lucida, for they change their place before it is possible to trace the entire outline.

Mr. J. D. Hyatt read an interesting letter from Rev. Samuel Lockwood, concerning some shells in a marl bed in New Jersey bored by a sponge, and showed some specimens illustrative of the subject.

Mr. W. H. Mead exhibited and described a Nachet travelling microscope, which was provided with one of the

Nachet spring nose-pieces instead of a screw, for attaching objectives.

Mr. A. D. Balen showed some fine desmids, *Closterium*, *Cosmarium* and *Micrasterias*, and also some fine specimens of living rhizopods which he named *Diffugia*.

Mr. Van Brunt exhibited a very remarkable preparation of the diatom *Bacillaria paradoxa*, which showed the frustules burnt upon a cover-glass, maintaining their position just as in life. This preparation was made by adding alcohol to the water containing the diatoms. They were suddenly killed, and did not separate.

At a meeting of the Microscopical Society of CENTRAL ILLINOIS, the following officers were elected for the ensuing year: Rev. J. A. Reed, president; Dr. G. N. Kreider, vice-president; Sergeant T. B. Jennings, U. S. Signal Service, secretary. After the transaction of regular business, Sergeant Jennings began the reading of his paper, entitled "Some Things I Have Seen in the Waters from Reservoir Park." The sergeant has been studying this water for the past two years or more, and this paper is the result. The first section, devoted to Protozoa, was taken up, and a technical description of what constitutes a protozoon read.

At a meeting of the ILLINOIS STATE Society, Dr. R. Tilley gave an account of the theory of development and life-history of the blood-corpuscle as advanced by Dr. Richard Norris, of Birmingham, England. The chief points were as follows: There exists in the blood an absolutely colorless corpuscle, and others of gradually increased shades until we reach the ordinary red color. The colorless disc is the young corpuscle just thrown into the blood channels from the lymphoid organs. The red corpuscle is the corpuscle approaching its dissolution. The colorless disc is invisible because it is of the same specific gravity and index of refraction as the plasma. The discs can be rendered visible by various reagents and mechanical devices. The formation of the fibrin of the blood is due to the coalescence of these colorless discs. A discussion followed the reading of the paper, in which Dr. Curtis, Mr. Fellows, and others took part. Dr. Tilley succeeded in giving a fine demonstration of the presence of the colorless corpuscles in the blood.

NOTICES OF BOOKS.

The Bacteria: An Account of their Nature and Effects, together with a Systematic Description of the Species. By T. J. Burrill, Ph. D., Professor of Botany and Horticulture, Illinois Industrial University; Botanist Illinois State Board of Agriculture. (Pamphlet, pp. 65.)

This pamphlet is taken from the Eleventh Report of the Illinois Industrial University. The classification of the bacteria given in this pamphlet is a translation by the author from the latest edition of Rabenhorst's "Kryptogamen-Flora," based upon Cohn's arrangement, with a few additions by the writer. "As the work now stands the systematic description of species, herein given, is believed to be the fullest and most nearly complete of any in existence."

Annual Report of the Chief Signal Officer to the Secretary of War for the year 1880. Washington: Government Printing Office, 1881. (Pp. 1125, with numerous maps and illustrations.)

This valuable report contains a great amount of information which cannot fail to contribute largely to the knowledge of meteorological phenomena. To attempt to afford even a superficial idea of its contents would require more space than is at our disposal here.

Exchanges.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 108 Virginia St., Richmond, Va.

DIATOMACEOUS MATERIAL and Histological slides for other well-mounted and named slides of Foraminifera, Animal Parasites, Pathological subjects, etc. R. Cauch, M.D., Carpentaria, Cal.

SECTIONS: Kitten's Jaw, teeth *in situ*, in exchange for first-class slides. Jay L. Smith, 86 Beekman St., New York City.

FOSSIL DIATOMS from Carson, Nev., and Posa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

FOR SLIDES of Diatoms from the Wabash & Erie Canal at Ft. Wayne, send any well-mounted slide to H. C. Tresselt, Fort Wayne, Ind.

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No. 4.

The Movement of Diatoms.

BY CORNELIUS ONDERDONK.

Noticing that the motion of the diatomaceæ is attracting attention at this time, I desire to publish a few words preliminary to a more complete memoir on my own discoveries concerning the subject, having directed my attention to the motion of the diatoms during the past five years.

The motion of diatoms is caused by what I will call the motile *pallium*—a gelatinous, invisible envelope, that entirely envelopes the diatom in the case of the strong-moving naviculæ, but only partially in the case of other forms of weaker motion. This is no mere theory, though I had worked out the theory long before I succeeded in making the pallium plainly visible, and turned my whole attention to staining the motile matter long before I saw a trace of it. I have at length succeeded in staining, hardening, and detaching the pallium, and I now have many of them mounted, also many diatoms, in all stages of disrobement, if I may use the term. The pallium is folded to the diatom in many minute currugations. Under the action of the reagent, the minute currugations slowly begin to expand out from the diatom like pseudopodia; longer and longer they grow, but soon we see they are not pseudopodia, for they straighten out into a membrane. The unfolding mantle splits along the midrib, and, in some cases, leaves the flinty shell. This is not the membrane spoken of as investing the diatoms by many investigators, as this is at once destroyed by alcohol or acids. The same reagent reveals a similar

envelope on the oscillaria; and I believe the motion to be the same in the two forms of protophytes. In fact, if a diatom was a long elastic rod, it would merely vibrate, for I have observed that the motion is generally in opposite directions on the two valves; but the diatom can only move by creeping along a surface, hence, its motion is only affected by the direction of the motion of the gelatine on one valve—the one that comes in contact with a surface. The motion is only on the sides, or valves. If a frustule is turned with its so-called front view up, it cannot move, at least those under my investigation did not, unless one of the valves comes in contact with some body of greater weight than itself, if we may so put it; for small particles will move along the valves, while the diatom remains stationary. The ribs have much to do with this power to creep, for the pallium is folded to the ribs and being striated length-wise, it is plain to see how the pallium covers the valves with thousands of little feet. There is great room here for investigation with the recent very wide angled glasses, but let me here give common glasses their due, for all that I have discovered has been done with only such.

I will, when I can find the time, publish the *modus operandi* for revealing the pallium.

[It is to be regretted that the author of the above article has not given his method of observation, at least in outline. It cannot be expected that his statements will receive much credence in their present form. It is for us to give to the world the results of original

investigations, and if the author of this article has made a discovery, it is right that we should give it publicity. Yet our readers would like some better assurance than is offered above, that a pallium such as is there described has been found. It is only reasonable that a more definite account of the observations should be asked for. The method of staining should be immediately set forth. We were at first inclined to reject the article because the reagent used was not mentioned, but we prefer not to be too arbitrary in such matters, as there may be adequate reasons for withholding the details, of which we know nothing.—ED.]

Pond-life in Winter.

Though it is not uncommon to see in Microscopical magazines statements by editors and contributors that pond-water in winter furnishes many interesting objects for observation, I have always been deterred from collecting any of that material during the cold weather, partly by the trouble of penetrating the ice, but chiefly by the conviction that I could always obtain better specimens from my own in-door aquaria than from any frozen pond.

In case other readers of this JOURNAL may have been prevented by similar reasons from obtaining winter pond-water, perhaps they will be interested in the following memoranda of the microscopical examination of the first sample of that material which I ever had the good fortune to secure.

Towards the end of last January a friend gave me about an ounce of pond-water containing a small green spray of some aquatic plant and a little sediment, the latter amounting, when well settled, to about one-eighth of the bulk of the water. My friend said that he had just obtained the water through a hole cut in the ice of a pond and that it seemed very rich in infusoria.

I have had this water under more or less interrupted observation ever since, and have been amazed at the variety of microscopical life which it has displayed. I believe that I have never before seen in any single dipping of pond-water, so many and such diverse specimens for microscopical study.

All the animalcules seemed to be in the most healthy, active, and vigorous condition. The tardigrades and floscularians were the largest and finest I have ever seen. One specimen of *Floscularia ornata* contained in its tube twelve eggs, which I presume is an unusually large number, as it is stated by Pritchard that Ehrenberg had never counted more than five, but that Mr. Gosse had on one occasion observed nine. I also noticed in this water the largest and most beautiful colony that I have ever seen of that interesting rhizopod *Clathrulina elegans*. It consisted of no less than nineteen individuals all connected to one another by the same system of stems. Indeed, with but few exceptions, the water in question has furnished specimens of all the more striking of our Maine animalcules. Among these exceptions, however, are some of the largest and most interesting forms such as *Lophopus*, *Hydra*, *Conochilus volvox*, *Melicerta ringens*, which abound in our summer waters, and the *Stephanoceros*, which is more rarely seen though last summer I collected about twenty specimens and raised in aquaria perhaps a hundred more.

It may not be out of place for me to say that my scrutiny of this water commenced only a few hours after it was taken from the pond, and that it then contained apparently quite as great a variety of active animal life as it has shown at any time since,—though some forms which I did not at first notice afterwards made their appearance, replacing others which became extinct. The water has shown the customary succession of microscopic creatures which is to be

noticed in bottled pond-water, and I suppose ultimately nearly all the smaller beings will be exterminated by *Daphnia*, *Cyclops*, or naiadine worms, and most of the larger ones by simple starvation. But up to this time many forms have been noticeably constant; for instance, less than twelve hours after the water was taken from under the ice, I found in it the largest and most magnificent floscules I have ever seen, also very large and fine tardigrades. These same creatures are as large now, and perhaps nearly as abundant, as ever, but have a more or less pale, shrivelled and sickly appearance.

I append a list of the organisms which I have observed in this single ounce of winter pond-water as far as I have been able to identify them by the aid of the books at my command, but I confess that the catalogue is very incomplete for many creatures that I saw could not be reconciled with any figure or description given by Pritchard or Kent.

Among the algae were many varieties of *Spirogyra* and *Oscillatoria*, *Raphidium polymorphum*, *Protococcus*, *Chroococcus refractus*, the desmids *Scenedesmus quadricauda*, *Closterium acerosum*, *rostratum* and *Ehrenbergii*, *Micrasterias Americana* and *Furcata*.

The rhizopods included *Amæba proteus*, *Diffugia pyriformis*, many varieties, *acuminata*, *globulosa* and *corona*, *Arcella vulgaris* and *artocrea*, *Centrophyx aculeata*, *Euglypha ciliata*, *Actinophrys sol*, *Actinosphaerium Eichhornii*, *Acanthocystis chaetophora*, *Clathrulina elegans*.

The diatoms included *Diatoma vulgare*, and two or more species of *Tabellaria*, *Coconeis*, *Navicula*, *Pinnularia*, *Stauroneis*, and *Gomphonema*.

Among the infusoria were — *Trachelocera olor*, *Kerona polyporum*, *Vaginicola crystallina*, *Vorticella microstoma* and *campanula*, *Epistylis nutans*, *Megalotrocha albo-flavicans*, *Microcodon clavis*, *Notommata tigris*, *Synchaeta pectinata*, *Monocerca bicornis*, *Mastigocerca carinata*, *Rotifer vulgaris*, *Philodina roseola*,

Distemma forficula, *Stentor polymorphus*, *Tardigrada* sp., *Dinocharis pocillum*, *Limnias ceratophylli*, *Coleps hirtus*, *Metopidia acuminata*, *Lepadella*, *Chaetonotus larus*, *Trachelius anas*, *Floscularia ornata*, *cornuta* and *trifolium* (?), *Anguillula pluviatilis*, *Euglena viridis*, *pleuronectes*, and *deses*, *Cyclops quadricornis*, *Daphnia* sp., *Nais* (several worms of this tribe). The water also contained a great variety of smaller infusorians.

The collector of the water above mentioned has since informed me that it was obtained on January 25th from the bottom of a small pond having neither outlet nor inlet (but possibly supplied by a spring), which lies in a depression in an old pasture. This little pond is not more than eighteen feet in diameter, and then contained from 4 to 6 feet of water covered by ice 10 inches thick upon which lay 3 feet of snow.

J. C. S.

BANGOR, Maine, Feb. 29th, 1883.

A New Lamp-Shade.

Mr. Wm. J. Morrison has sent us a description of a form of lamp shade applicable to a student-lamp, with photographic illustrations. Instead of the ordinary porcelain shade, a similar, conical shade of tin is provided, having a cylinder extending nearly to the top of the chimney. A similar conical shade (without any chimney however), extends downward from the shading-ring, so that the light is entirely confined by the two cones — except what reaches the ceiling from the chimney. The lower cone has an opening of suitable shape and size to allow the light to be directed upon the mirror.

We have seen, at Mr. Woolman's store, an excellent shade for a common hand-lamp. It consists of a black metal cone fitting over the chimney, with an opening cut near the bottom for the light to pass through to the mirror. The cone simply hooks over the top of the chimney.

The use of shades of some kind is very desirable, saving the eyes from strain, and in warm weather greatly lessening the annoyance caused by nocturnal moths and insects, which are attracted indoors by the faintest gleam of light.

Mr. Morrison states that his shade can be made by any tin-smith, and it should not cost more than fifty cents. His address is Moorestown, N. J.

Labeling Slides.

Let me give the readers of the JOURNAL a little device which I have found of much service in labeling slides. It often happens that the label does not afford room enough to contain the facts which should accompany the specimen. In such cases I write all I can on the back of the label with a medium hard pencil, and then, with a mucilage made of gum arabic one part and gum tragacanth four parts, I attach the label to the slide in the usual way. As soon as dry, I finish the labeling by writing the rest in ink on the upper, or face side, of the label. The pencil writing on the back can be easily read through the slide, simply on turning it over. In this way I utilize both sides of the label.

SAMUEL LOCKWOOD.

FREEHOLD, N. J.

Curious Process of Division of Hydra.

I enclose drawings of a *Hydra* as seen on February 1st, 2d and 3d. Fig. 15 *a* is its condition on the 1st: when observed I immediately isolated it to more readily watch it. On the morning of the 2d there appeared

a gathering of substance at one side, as seen in *b*. On the evening of the same day there was a division in the center longitudinally as shown in *c*. On the 3d it appeared as represented

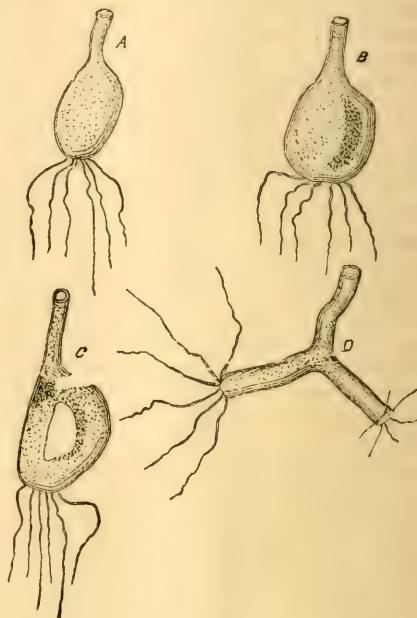


FIG. 15.

in *d*. All the authorities at my command state that the *Hydra* increases by budding; this is certainly an exception.

T. B. JENNINGS.

SPRINGFIELD, Ill.

New York Microscopical Society.

The fifth annual reception of the New York Microscopical Society was held on the evening of the 8th of March, at Lyric Hall. It was, in some respects, the most successful and enjoyable of all that have been given by the Society. Between four and five hundred persons attended, and great interest was manifested in the objects exhibited, which had been briefly described on printed circulars.

The President, Mr. B. Braman, who has been reëlected for the present year, delivered the following short address, after which the folding doors were thrown open and the audience passed into the exhibition-room, where forty-eight objects were shown on sixteen round tables, under as many microscopes.

The President spoke as follows : —

LADIES AND GENTLEMEN : — Your attention is invited to a few thoughts on The Usefulness of the Microscope as an Instrument of Recreation.

Of recreations, those are the best which serve at once for diversion, for enthusiasm, for benevolence, for education. In the hands of a thoughtful man, few, if any, instrumentalities of recreation possess and unite these attributes in larger completeness and fuller harmony than does the employment of the microscope. It adapts itself to the tired mind's uncertain and imperious moods with sympathetic readiness and versatility. It commands the quickening quality of enthusiasm, and the sweet virtue of a frequent kindly thought of the happiness of other persons. At the same time it liberally informs the understanding and spurs the imagination.

1. It serves for diversion. The characteristic of a good diversion is that in a rational and pleasant way it lures a man into forgetfulness of his perishable goods, his business perplexities, and the sometimes harassing possession which he calls self. Let the man who is thus burdened take his microscope from its polished case, or from under its glass shade, and some pet microscopic objects from his cabinet, and in a moment he is borne away to the bank of the cool stream which yielded to him his elegant *Meridion Circulare*; or to sunny Brazil, where his Diamond-beetle arrayed itself right royally with emerald and opal. Or from his aquarium he selects a leaf of *Vallisneria*; and while the neat outlines of the rotating chlorophyll-

granules make him proud of the definition of his lens, he suddenly finds himself in his boat again on the forest-bordered lake beneath whose bright waters and on whose sandy bed the *Vallisneria* grew. Or, if he would as an artist have become a colorist, he reënforces his microscope with a polariscope, focusses his objective upon an evaporating solution of potassium chlorate, or upon the cuticle of the scouring-rush, and regales his eye with the witchery of crystal-building, or of ever-varying chromatic effects.

What the prince of dramatists said of the celebrated Græco-Egyptian queen,

" Age cannot wither her, nor custom stale
Her infinite variety,"

may with ten-fold emphasis be affirmed of the resources of diversion which the microscope places under the control of its master.

Unlike many other instruments of recreation, the microscope can exert its beguilements daily; and daily diversion is as important as daily work in procuring and preserving that joy of life, a sound mind in a sound body.

2. Microscopical recreation possesses the virtue of enthusiasm. Enthusiasm is as necessary to success in a man's recreations as it is to prosperity in his business pursuits. Some persons, unversed in the ways and experiences of amateur microscopists, may conceive microscopy to be a dull and solitary rather than a zestful and social divertisement. Let such stand as spectators where two or more of these modern Knights of the Round Table are engaged in joust or tourney — with their good stands in place of fiery steeds, and with their fine oculars and objectives in place of tough lance and trusty sword. All the resources of a carefully trained intelligence and dexterity they will there see applied to the handling of mirror and condenser and diaphragm, for the defining of some obscure structural feature, or for the resolution of some in-

tractable diatom, that the merits of their lenses—a Spencer, a Tolles, a Wales, a Zeiss—may be ascertained or displayed. The enthusiasm of these lens-combats is invigoration, refreshment, rest.

There is zest in solitary recreations with the microscope, as well as in social. It is generally conceded that no diversion is more absorbing than the chase. Now, here is a drop of water, containing, I surmise, sundry microscopic organisms. I look. The most cunning fox never tangled his scent by movements more swift or more bewildering than are those by which the animalcule which I here descry, baffles the pursuit of my vision—now in the field, now out; now in and out again. And the gills of this oyster—why, I could gaze upon the perfect rhythm and indescribable beauty of the movements of their cilia, with a zest which could take no note of the passing of even the midnight hour.

Zest in observing begets zeal for discovering, and zeal in the search after objects for the microscope, as much as after any other, renders a man's summer saunterings in field and forest an Elysium of delight, a re-creation of mind and body.

Enthusiasm is magnetic. The enthusiasm of the amateur microscopist is doubly so, creating and cementing friendships; and these friendships make Microscopical Societies fraternities.

3. Recreations with the microscope minister to benevolence. I have never known an amateur microscopist who did not wish and invite his friends and acquaintances, or even strangers, to share his delight in looking at those beautiful structures and watching those interesting phenomena which are beyond the ken of the naked eye. I have often known him, under the impulse of sheer good-will, to take valuable time from his business and devote it to the patience-taxing work of persuading a recalcitrant frog to keep his foot quiet an hour or two for the promotion of human happiness and

the instruction of the human understanding.

4. Recreations with the microscope serve for education. The effort of devotion to a systematic course of study without stimulus and direction from the living teacher, is not often an easy or a successful one. In the absence of such teacher the microscope is the most efficient of instructors, its use tending to sharpen perception, to store the memory, to excite the reasoning faculty, and to kindle the imagination.

The best moment for study and acquisition is the moment of interest. The moment of interest in an object is, generally, the moment of the first clear perception of that object, especially through the eye; for an impression on the mind through that organ is vivid, because instantaneous, precise, and full. Vividness of conception, embracing part of an object, is the parent of curiosity and inquiry respecting the whole. So, persons proficient in the subject are consulted, books of explanation are sought after, and a library accumulates; and as the objects of the microscope are unlimited in variety and number, representing every department, particularly of animate nature, and drawn from every quarter of the globe, the short but enthusiastic daily excursions of the intelligent microscopist will, in a comparatively brief period, make him proprietor of an inexhaustible fund of exact, entertaining, and useful knowledge.

Not only is his memory richly furnished with facts, but the edge and the point of his reason acquire keenness through his study and contemplation of the marvellously ingenious adaptations of means to ends displayed in organisms or parts of organisms in which, but for the stimulus of a microscope, no thought of his might ever have been bestowed. Besides, under this mental excitation, he will be tempted to make excursions into the mathematics, into physics, into chemistry. On the basis of data furnished

by Sir William Thomson, Prof. Maxwell, and other distinguished physicists, he may undertake to compute the number of molecules in the smallest particle of matter recognizable by the unaided eye; and if he find it to exceed, as he certainly will, the number of letters contained in two billions of Bibles, he may next compute the number of molecules embraced in the smallest particle clearly discernible under the best existing high-power objectives. Finding the multitude of molecules even there far too vast for conception, he might, in the interest of curiosity and speculation,—and only, I think, in that interest,—calculate the lens-power and the illuminating power necessary for grasping an individual molecule and for thus revealing to man's unresting research the *modus operandi* of those mysterious energies, the molecular attractions.

The revelations of the microscope enlarge the domain over which beauty reigns and imagination casts its spell. To the uninitiated observer, the green scum on the surface of a stagnant pool is a green unsightly scum—and it is nothing more. To the vision of the microscopist it is an exquisite piece of living tapestry. To the mind of the one, the ooze of the ocean's bed is a slimy and repulsive thing. To the intelligence of the other it is a precious casket protecting, and ceaselessly inviting and receiving into its protection, innumerable myriads of exquisitely sculptured creations. The former discerns in the oak its external aspect and expression only; the latter discerns all that, and a great deal more. He looks into the tree,—the roots, the trunk, the branches, the leaves,—into and through the whole, as if it were transparent, like crystal; and he beholds the inscrutable, the God-suggesting, and shall we not also say, God-requiring life-force, building air and light and dew into buttressed walls and spiry domes, and climbing with laughter to the sun-kissing leaves, or descending with glee to the joyous earth.

Now I believe and I affirm that by no amount of skill of text or diagram or picture alone, can our conceptions of this omnipresent microscopic life and sculpture and architecture be rendered vivid enough for such clear and comprehensive insight. This insight, this power to transmute blank opaqueness into structure-disclosing and beauty-revealing transparency, is the prerogative of an imagination which has acquired its conceptions through the eye—that eye viewing the actual object in its details and in its completeness.

Sir Richard Steele wrote of the Lady Elizabeth Hastings, "To love her was a liberal education." Is it too much for us to say of the microscope that to love it is a liberal education?

Therefore to him who, immured in professional cares through the day, wishes a delightful and profitable occupation of his evening hours, I, with full soul, recommend the acquisition of a mastery of this "myriad-minded" instrument, the use of which may serve at once for diversion, for enthusiasm, for benevolence, for discipline and knowledge.

At the conclusion of the address the objects were all ready, and while a portion of the audience was looking at them the rest listened to music well-rendered by Stube's orchestra.

It is not desirable to attempt even a general description of the exhibition in this place. Mr. F. W. Devoe gave a fine exhibition of the respiratory and circulatory system of the oyster, which, being explained at length in a special circular, with illustrative cuts, specially prepared for the occasion, attracted much interest. From the circular we abstract the following description of the living specimens shown by Mr. Devoe:—

"An oyster is enveloped in a thin, loose membrane, called its pallium, or mantle. This pallium is united for a little way at the left side of the animal, and all round the right side, but at the posterior end it is free. Let us

look at this large diagram. I have torn off the right side of the cloak, thus exposing the animal, which, with the flat shell removed, is represented as lying in the round or dished shell. This leaves the prominent organs exposed. The edge of the pallium is beset with rather coarse, fleshy hairs, which are cilia. As there are two edges, they make a double fringe. When the shell is a little bit open this ciliated fringe is slightly projected, and is called the beard. The two fringes keep up an incessant vibrating action which sets the water flowing in between them; and another contrivance, soon to be described, carries the food-laden water forward over the body, or ventral side of the animal, up to this spot near the hinge, where it is received on the edges of four flattish lips, the mouth being between the two pairs. We may call these organs palpi, or labial fingers; for they assort this food from the water, which done, the water thus filtered is passed backward on the dorsal side, by innumerable and invisible lashes. I said invisible, for it requires a high power of the microscope to detect this mystic mechanism. Analogy compels us to believe that it is a similar ciliated movement which carries the food down the alimentary canal.

* * * * *

"Perhaps even more beautiful is the respiratory system. Here, in the posterior part of the animal, so as to be near the water, are the branchial plates, or gills. Like the palpi, they are in two pairs, one pair for the left side and one for the right. They comprise an infinity of little tubes, so small that the unaided eye cannot distinguish them. Each tubule has on one side a row of holes, as if it might be a tiny flute. On these little tubes are innumerable myriads of little cilia, inconceivably small. To see them well taxes the microscope. And how busy they are, as if each tube might be a tiny trireme, manned through its whole

length with the little rowers, rowing, rowing, rowing. The function here is very strange, because it seems twofold. All over the animal are these cilia, and all are lashing the food-laden water to the anterior, where is the mouth. Now, these branchiæ, with cilia on their outer surface, lend their aid to produce this general movement of the water; but to the branchiæ this is only a secondary function. There are millions of these tiny cilia between these gill-flaps, and their primary function is the aeration of the blood. To effect this the filtered water which has left the palpi, or lips, is now lashed by the cilia into the holes of the tubules in the branchiæ; here the air is taken out, and the oxygen eliminated, and the now carbonated water is passed on to the cloacal region, while the opal-hued and oxygenated or revitalized blood is passed to its destination.

* * * * *

"This brings us to the circulatory system. Looking at our diagram we see here a dark crypt, a little mystic chamber. It is the pericardium, or receptacle of the heart. This vital crypt is covered with a thin membrane or translucent caul. Let us in a reverent spirit, put aside the veil, and look in. Here we see the little heart. On the right is its one auricle, receiving the oxygenated blood from these ducts which connect with the gills; and here is the ventricle into which the auricle discharges, and here are two aortas by which the ventricle supplies the blood to be distributed through the one to the posterior parts, and through the other to the anterior parts. It is a wonderful sight. In a freshly opened oyster I have counted the pulsations at six in a minute. Probably in a specimen just from the water it might be as high as ten in a minute. It is not difficult to demonstrate that the oyster has a complete apparatus of arteries and veins.

"Thus it seems that so far as its necessities reach, the three physiolog-

ical systems are as well developed in an oyster as in a man. But these systems now discussed have their analogical functions in the life of a plant. Hence the three groups of organs, taken together, are often called by the physiologist the vegetal system."

Mr. J. L. Wall showed the circulation of blood in a frog's foot, Mr. W. H. Mead the circulation in the tail of a gold-fish, Mr. Mitchell cyclosis in *Nitella*, Mr. Hitchcock the blood flowing through the yolk-sac of a young fish, Mr. Van Brunt a bouquet of insect scales, Dr. Schöney showed the *Bacillus tuberculosis*, and Mr. Balen had some fine living objects from ponds in New Jersey. Taken as a whole the exhibition of objects was exceedingly fine, and the Society is to be congratulated upon the success of its efforts to make the public acquainted with some of the wonders revealed by the microscope.

A Method of Preserving and Coloring Protozoa.*

BY DR. HENRI BLANC.

The following method has been satisfactorily employed by the author for a year and a half. Kleinenberg's liquid, picro-sulphuric acid, has been recommended. It is this acid that is used by the author, composed as follows:—

Concentrated picric acid,	100 vols.
Sulphuric acid,	2 "
Distilled water,	600 "

To this solution, which is used for preserving the larvæ of echinoderms, medusæ, and sponges, there is added, specially for the rhizopods and infusoria, about one per cent of acetic acid; two or three drops to 15 cubic centimetres of the liquid. The addition of this acid is to preserve the nuclei and nucleoli.

Thus prepared, the solution is pre-

ferable to osmic acid, for the organisms are perfectly well fixed, and it permits of a more certain coloration.

After fixing, the picro-sulphuric acid is removed by alcohol of 80%, which is renewed until the yellow coloration has entirely disappeared. It is then replaced by alcohol of 96%, and finally by absolute alcohol.

The organisms are then stained either by picro-carmin, or by an alcoholic solution of safranin, 5 grains dissolved in 15 c.c. of absolute alcohol, and in a few days filtered and diluted with half its volume of water. This solution is preferred to the picro-carmin.

This method is recommended not only for the preservation of protozoa, but for other microscopic animals—in particular for marine nematodes.

Vibratile Cilia and Ciliary Motion.

BY CHAS. S. DOLLEY, M.D.

SUMMARY: Historical.—Distribution of vibratile cilia among animals.—General appearance of vibratile cilia.—Ciliary motion.—Effects of temperature changes, electricity, and various reagents upon ciliary motion.—Vibratile cilia and ciliary motion in the vegetable kingdom.—Ciliary motion as accompanying a sexual reproduction in cryptogams.—Ciliary motion as accompanying sexual reproduction in cryptogams.—Vibratile cilia in plants other than spermatozooids and zoöspores.—Rationale and function of ciliary motion.

HISTORICAL.—Glancing hastily over the bibliography of our subject, we find first in the field that great pioneer of microscopy Anton Leeuwenhoek announcing in enthusiastic letters to the Royal Society of Sciences of London, the discovery of little animals (thierchen) possessing vibratile tails and existing in human semen; which discovery he accredits to Johannes Ham, of Arnhem, as having been made as early as 1677. Leeuwenhoek soon followed this announcement by those observations in which he opened up that richest of

* Condensed from *Zool. Anzeiger*.

all fields for the study of vibratile cilia, viz., the infusoria. At first as he noticed in the water the wonderful little forms he imagined, as Cohn tells us, that he saw the living atoms which, according to Democritus composed all bodies, and from whose whirling motion his contemporary Descartes believed the world "built itself anew." However, he soon became convinced that these were animalcules and accounted for their motion by the cilia, which he described. In 1683 Ant. de Heide, a Dutch physician, noticed the presence of vibratile cilia upon the branchial membranes of the common horse-mussel (*Modiola modiolus*) the movement of which he described as "*motus radiusus*" or "*tremulus*."

These discoveries having created some interest in the phenomena presented by vibratile cilia, they were shown, in the latter part of the last and the early part of the present century, to exist in the most widely separated members of the animal kingdom. The first connected examination and descriptions were given by Purkinje and Valentin, and a little later by Sharpey. In regard to the more important works which have since appeared, we will make reference in various places.* Steinbuch was first to discover the movement in vertebrates (tadpole and larvæ of salamander) while Dr. Grant was the first to demonstrate the existence of cilia as organs by which motion within the ovum is produced. He, however, seems not to have appreciated their respiratory significance.

DISTRIBUTION OF VIBRATILE CILIA AMONG ANIMALS.—Vibratile cilia are found very generally distributed throughout the animal kingdom. One class only, the articulata, is without them, unless we accept the classification of some naturalists and include

the rotatoria within this group, under the head of Cilio-articulates.* With the exceptions named, vibratile cilia are constantly found from the lowest to the highest grades of animal life, differing only in manner of arrangement, and existing, as a rule, on surfaces exposed to fluids or producing fluid secretions.

The unicellular protozoa (flagellata and ciliated infusoria) are signalized by a wonderful manifestation of ciliary organs, while the multicellular organisms, from sponges up to man, show the presence of vibratile cilia attached to epithelial cells, which, for the most part, are grouped together to form wide expansions of ciliated epithelium.

Animal spermatozooids are only modified ciliated, epithelial cells, in which the differentiation has produced but one cilium, the cell at a certain period of its career becoming motile.† The life-conditions of the spermatozoa are really the same as those of ciliary motion in general, and the movement of the appendage of the zoö sperm is exactly analogous to that of the cilium of *Bacterium termo*.

The presence of but one cilium is not anomalous among ciliated epithelial cells, and is by no means confined to spermatozoa, it having been noted, for instance, in Sponges and Hydroid polyps and in the winding urethral canal of the serpent, and in the auditory organs of the cyclostomum.‡

* The Crustacea possess the auditory cells with stiff cilia; also spermatozooids, with a number of appendages. These ciliary rays may be withdrawn and the seminal element assume a spherical form.

† "According to Schweigger-Seidel the seminal element is not simply a modified nucleus, but corresponds to an entire cell, as a metamorphosed singly-ciliated cell." Pflüger describes the seminal element as a small ciliated cell and attributes its formation to free-cell formation.

‡ On the other hand we see the seminal filaments of the tardigrade arachnida possessed of two terminal vibrating tails, and those of *Paludina viripara* having a tuft of short cilia springing from their thicker ends (Leydig).

* It would be impossible to make complete references to the extensive literature on the appearances and structure of ciliated cells among the invertebrates.

GENERAL APPEARANCE, ETC., OF VIBRATILE CILIA.—The differentiation of vibratile cilia takes place only in the superficial layers of protoplasm, or in the superficial layers of cells of some epithelial tissues. Thus, in the protozoa, the cilia are attached directly to the tissues of which they form a part, while in all the higher orders we find unmistakable evidence of an epithelium. In most cases the cilia are arranged in regular order,—in circles, spirals (in many infusoria), or in straight rows (gills of mussels and other epithelia); they usually stand erect, and at right angles to the surface on which they are situated. They are transparent and homogeneous throughout, and for the most part colorless, though in some instances (sea mussels *e.g.*) a slight brown or yellowish-brown tint has been observed. Their usual transparency and lack of color has been the cause of their presence being overlooked in many cases, the difficulty of seeing them while in motion being well shown by the endeavors of Messrs. Dallinger and Drysdale to demonstrate the presence of cilia in *Bacterium termo*.

Cilia are, as a rule, firm, pliable, and elastic, and in the infusoria and other invertebrates may sometimes be split up into bundles of finest hairs, by means of pressure or chemicals. They are doubly refractive, and uniaxial, the optical axis in all cases coinciding with the direction of greatest length. In form they may vary somewhat, but are generally slender, conical or flattened filaments, broad at the base or root and tapering gradually to the point. Ehrenberg describes compound cilia in the infusoria. In ciliograde medusæ the cilia are broad, flattened organs, each of which is made up of several single filaments, joined together throughout their whole length by a connecting membrane presenting the appearance of an undulating, homogeneous membrane, which may also be observed in the seminal filaments of the sala-

mander, triton, bombinator, and in many infusoria; while leaf-shaped cilia are to be seen in some invertebrates.

In all ciliated epithelial cells of higher animals, and in most of the spermatozoa of animals and plants, the shape is as first described, *i.e.*, small, slender, conical hairs. As to size, vibratile cilia may differ even in the same cell, as well as in different parts of the same animal and in different animals. Their thickness is scarcely measurable, but in length they range from the unparalleled undulating hairs of the infusorial parasite *Trichonympha agilis*, Leidy, to the minute cilia of the human trachea (0.003 to 0.005 mm).* They have been observed to be longest in marine animals and spermatozooids.

The number of cilia implanted upon one cell in ciliated epithelium in vertebrates, ranges from ten to thirty, but we find exceptions to this rule, as in the instance already noted of the cells of the uriniferous tubes of the serpent, which have but one. The presence of a single, usually very long, hair is frequently met with in the epithelial cells of invertebrates† as well as in spermatozooids, protozoa, and algæ. Such cells are termed flagelliform cells, in contradistinction to ciliated cells proper; while those unicellular organisms provided in this manner are separated from ciliate infusoria in general, under the name flagellata.

The shape and size of the cells to which cilia are attached are not considered characteristic. They are often cylindrical, often flat or squamous, and always contain a spherical or oval nucleus which may conceal one or

* Human Epididymis 0.022 to 0.034 mm. Coni vasculosi 0.0114 mm., Branchial laminae of *Buccinatum undatum* 1-500 inch, Swimming organs of *Ctenophora* 1 mm. Organ of Jacobson in Rabbit 0.0054 mm.

† In *Flustra carbesia* Dr. Grant estimates the number of cilia upon a moderate sized animal as forty millions,—about fifty on each side of a tenaculum.

more nucleoli. There is usually to be distinguished both an intracellular and an intranuclear reticulum, of the fibrils composing which some histologists contend the cilia are but prolongations. With this view I do not agree, but I consider cilia to be specially differentiated products (the movements of which are not effected simply by the contraction of this intracellular network)* having their origin in a thin hyaline layer of protoplasm which, similar to the *stratum bacillosum* of intestinal epithelium, forms a sort of cover to the proper protoplasm of the cell. Vibratile cilia are not protuberances of the cell-wall, but if such exist they pass through it. In many cases the juxtaposition of ciliated cells is so intimate that this cover may be removed as a cuticle, from quite extensive surfaces.

Ciliated epithelium is classified as:

1. Ciliated Pavement Epithelium, in which the cells appear as those of simple pavement epithelium, with the free surface thickly set with cilia. This variety is, for example, to be found in the tympanic cavity and in the ventricles of the brain, as well as in the peritoneal cavity of the triton and frog.†

2. Ciliated Cylindrical or Columnar Epithelium. Either in a single stratum or laminated, this is by far the most common variety, and occurs in the positions shown in the diagram of human ciliated epithelia, and in simi-

lar positions in other vertebrates besides in a few exceptional situations (e.g., kidneys of some of the lower vertebrates).

CILIARY MOTION.—If we place beneath the microscope a portion of fresh, ciliated epithelium in which the movement is at its height, we will at first be unable to distinguish the movement of single cilia, or of the cilia as a whole, the movement only being made manifest by the rapid current induced in the fluid bathing the membrane, solid particles suspended in this fluid, such as blood-corpuscles and the like, being driven over the surface in rapid flight. After a time however, as the vitality lessens, the movements reach a declining or weakening stage, in which it may be closely inspected and analyzed for a considerable length of time. The cilia of all epithelia will be found to execute regular, periodical and rhythmic motions, vibrating to and fro in planes which generally stand perpendicular to the surface of the cell. The directions of movement in neighboring cilia are parallel and constant, being at the same time usually parallel to the long axis of the organ in which they are found.

Every entire oscillation consists of two partial oscillations of unequal duration; first a gradual contraction or bending backward, followed by a forward sweep of double the rapidity, the difference in the force of this backward and forward motion causing the current to proceed in one direction. The more forcible stroke is so rapid that in healthy action it may not be seen, the contracting or bending alone being visible; hence, as we have already indicated, the weakening stage is the best for examination. Quekett* noticed in the gill of a mussel a slight movement of the cilia on themselves, each cilium turning on its axis through the space of a quarter circle, with a movement like the

*Nor by the contractility which is already inherent in the protoplasm. The indications of their identity with protoplasm cannot be seen in the more differentiated forms of cilia, but in some of the lower organisms, cilia are formed for a time and again drawn in and their substance fused with the protoplasm. This would go to prove that they are differentiations of, and that their movements are due to the same cause as, the movements of the protoplasm.

† In these animals small ciliated pavement cells are found scattered singly or in groups among the non-ciliated cells on the peritoneum pavitale, the mesentery and in the latter animal on the peritoneal surface of the *Cy terna magna*.

* Besides Engelmann and Valentin.

"feathering" of an oar, while other observers have seen in the same animal, an entire row of cilia suddenly turn themselves as though by a shock, and proceed to strike permanently and rapidly in the opposite direction, frequently returning as suddenly after a time to the old direction. This has never been observed in vertebrates. According to Krause (1841) and Engelmann (1867) the number of oscillations in a minute ranges from 180 to 620. Valentin* gives the following table as the result of some fifteen observations:

ciliary motion have been observed and classed as follows: (1) Hook-shaped, in which the cilium during the forward movement is bent forward like a strongly flexed finger. This would seem to indicate that the cilia are strongly contractile throughout their whole length. (2) Undulating or flagelliform type of movement, especially well shown in the long cilia already referred to in *Trichonympha agilis*, Leidy, and also in the spermatozooids of the frog, the undulations proceeding from the base to the tip of the cilium. (3) The vacil-

PART.	Condition of the Ciliary Movement.	Number of Oscillations in the Minute.			Number of observations.	Part of Second Occupied by an Oscillation.		
		Maximum	Minimum	Mean.		Maximum	Minimum	Mean.
Branchiæ of Mussel.	Lively.	100	150	125	—	0.6	0.4	0.48
Mouth of Frog.	Lively.	96	152	130.2	10	0.625	0.395	0.46
Lung of Frog.	Ceasing a little later.	77	96	85.75	4	0.78	0.63	0.70

The oscillations of all the cilia upon the same cell are isochronous. Their frequency is, however, to a high degree dependent upon outside conditions (temperature, moisture, etc.).

The amplitude of the oscillations likewise varies very much with the variety of the cell and the external conditions, but it is always alike at the same time for all the cilia situated upon the same cell. In ciliated epithelium the amplitude usually amounts to from 20° to 50° but at times exceeds 90°. During the oscillations the cilia, especially the short varieties in ciliated epithelia, remain unchanged as to form, either stiff and straight, or slightly concave towards the front (mollusca). Besides that already described, four varieties of

lating motion, in which the movement becomes pendulous, the to and fro strokes being equal; the plane of oscillation however, being very changeable. This form has been observed most frequently in spermatozoa, and the lower organisms, but also in molluscas. (4) Funnel-shaped movement. This form is the exception in all true ciliated epithelia, and contrary to the rule in all kinds of flagellate cells.* It is, however, seen, according to Sharpey, in the slowing stages and is characterized by the point of the cilium defining a conic section and the cilium itself the surface of a cone. While the movements of all the cilia belonging to the same epithe-

* It has been noticed by Hofmeister in plants (zoospore, etc.), and by others in the spermatozooids of the canary, etc.

* Purkinje and Valentin, "Physiologie."

lium or to the same ciliated surface are not isochronous, as they are in the single cell, they are repeated with equal frequency and are definitely successive; this gives rise to the often quoted wave-like appearance, which, as it runs over the ciliated surface, suggests the movements of a field of grain in a strong wind. This phenomenon is microscopically apparent in the ctenophora. The direction of these waves is quite constant, but may suddenly change to the opposite direction, in consequence of the cilia reversing the direction of their more forcible strokes, as we have already noted. The velocity of the waves is directly in accord with the frequency of the oscillations, and therefore dependent to a marked degree upon external conditions.

For the purpose of estimating the velocity of the cilia-propelled currents, and the force exercised, several ingenious methods have been employed. The velocity of the current is only to be measured by very easily moved bodies placed upon the membrane; for this purpose a strip of ciliated mucous membrane is stretched out to its normal length and breadth, and the time required for a light body (*e. g.*, a bit of sealing wax, suspended by a thread from a cocoon) to pass over a certain distance is calculated by means of a metronome. The apparatus used in this method has been designated the "ciliary-clock." Another, the "ciliary-mill," consists of a light cylinder carrying a swinging index, which is placed upon the membrane. One revolution of this cylinder is indicated by means of the passage of an electric spark through regularly arranged apertures in another cylinder covered with blackened paper. From the intervals between the marks made by the sparks, and the known rapidity of rotation of the paper covered cylinder, is indicated the angular velocity of the axis, which may be considered as a measure of the velocity of the current.

By these two methods the velocity

has been calculated to be, from 4' to 24 mm. a minute. Compared with muscular strength, the energy exhibited by cilia in bending themselves is very great. Thus Wyman found that 48 grms. could be moved along when brought in contact with 14 square mm. of ciliated surface, and in the experiments of Bowditch the loaded surface carried along 6.805 gramm-millimeters per cubic centimeter per minute.* When it is remembered that only the basal portion of each cilium performs the work, it will be better understood how great is the force compared to that of the heart. Thus Bowditch calculated that every cell could, at the maximum, raise a weight equalling its own, to a height of 4.253 metres in one minute.

Cilia, with the exception, perhaps, of seminal filaments, move themselves only so long as they remain in connection with their proper cell-bodies. Yet it would seem that it is only that portion of the cell protoplasm situated about the bases of the cilia which serves for the maintenance of motion. Engelmann observed the liveliest movements in the cilia of the gills of an oyster in which the nucleus-bearing half had been accidentally separated from the cilia-bearing portions. We may often see in infusoria which have been mangled, or are undergoing dissolution, a single cilium, to which a small portion of the body-substance remains attached, continue in active movement for a long time. On the other hand, the tails of many spermatozooids move themselves when completely separated from their bodies, approaching in this respect, as in many others, ordinary protoplasmic fibres.* From these facts we are inclined to doubt the theory that

* Engelmann recommends the use of the mucous membrane of the palate and œsophagus of the frog in measuring the power of cilia.

* The large pectinated cilia of ciliograde acalepha continue in the same manner their movements in parts severed from the body (R. E. Grant).

cilia are but prolongations of the intracellular or intranuclear network. In vertebrates, ciliary motion is entirely independent of the nervous system or of the general condition of the body, since no indications of change in the movement has followed either section or irritation of the nerve trunks approaching the respective parts. Ciliary activity is found to continue long after nervous and muscular sensibility have disappeared: in some cases, even after the liquifaction of the mucous membrane through putrefaction. In the turtle and other reptiles, it has been seen to continue three weeks after decapitation. In mammals and man, however, it seldom lasts for more than two days after death. Spermatozoids have been found living and active in the uterus, eight days after coitus. Thus, all that is apparently necessary to the indefinite prolongation of life in ciliate cells, is the maintenance of the fluid by which they are bathed, in a proper osmotic and nutritive condition, and within such limits of temperature, as we shall find hold good for all free protoplasmic bodies.

While it is the rule that vibratile cilia are independent of the nervous system, the will, and the circulation of the animal to which they belong, there are some exceptions. In the ciliated, swimming organs of the ctenophora for instance, the movement seems to be voluntary, due to a reflectively engendered irritation, conducted from the sense organs. In other invertebrates also, when ciliary motion serves for voluntary locomotion, we must consider it due to an innervation of the cilia without necessarily thinking of nerve trunks or fibres in a morphological sense.

(To be Continued).

At a meeting of the Rochester Academy of Sciences held March 12th, a resolution was passed inviting the American Society of Microscopists to hold its annual meeting, next August, in Rochester.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

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"SCIENCE."—The new weekly periodical *Science*, has been regularly issued since its commencement in February, and it bids fair to become an invaluable publication for all who desire to keep themselves informed of the progress of scientific investigation in this country and elsewhere. We are pleased to state that a number of copies have been furnished us, which we are at liberty to distribute among our subscribers. To any subscribers who will enclose a two-cent stamp for postage we will send a copy of *Science*, in the hope that they may find the paper worthy of their support.

THE POSTAL MICROSCOPICAL CLUB.
—The first box we have received this season is the box of circuit "H," which reaches us with only three slides in it, the rest having yet to be contributed by the other persons in the circuit. The first slide is a preparation of a larva found on the leaves of a squash-vine, the name of which is unknown to the contributor. It is certainly a very curious animal, but as we look at it we wonder how long it will be that we must see distorted and flattened balsam-mounted preparations of this kind, when it is so simple and easy to mount them without pressure. It is true that in this particular instance it might be objected that the larva was rather large—it would require a very deep cell. Nevertheless, this larva in its living condition under a low-power, would surely be far more instructive than in its present form.

The peculiar branching hairs are very curious.

The second slide is a section of fossil coral having walls of calcite—crystalline carbonate of lime—with quartz-crystals lining the chambers. The section is very instructive, and in polarized light is very beautiful. Mr. J. D. Hyatt, who contributes this slide, described the structure of the coral and the process of crystallization within it at a meeting of the New York Microscopical Society, not long ago, as will be seen by referring to the notices of the meeting already published in this JOURNAL.

Mr. G. I. Whitehead contributes the third slide, which contains a crustacean from a surface-dredging in the Indian ocean. A characteristic of this—as well as of all the other animals found in the dredgings—is the large, protruding eyes.

On the arrival of this box we were pleased to find the slide of *Spirogyra* which we contributed long ago—it must be two years ago if our memory serves us right. It was mounted in fluid, and comes back to us after a varied experience in mail-bags and in different climes, just as perfect as when it left our hands. Yet microscopists complain that mounts in fluid are not durable!

Our own contribution to this box is a beautiful species of *Ædogonium*—*Ædogonium Boscii* in fruit, showing the oögonia with the oöspores. This also is a mount in water, and we trust it will complete its journey as safely as its predecessor.

BRITISH FRESH-WATER ALGÆ.—

The fourth part of this work by Mr. M. C. Cooke has reached us. It embraces the families, *Vaucheria*æ, *Ulvace*æ and *Confervace*æ. The author treats his subjects well, with quotations from the latest authorities which cover the observations on the life-history of the plants. Of species of *Vaucheria* he has a variety of forms, but we question the distinctness of

several, particularly the two species *V. hamata*, and *V. terrestris*. The claims made for the distinguishing features of the two forms we find occurring in common. *V. tuberosa*, A. Br., of which we have three varieties, does not appear to be a British plant. *V. soricea*, should be *sericea*, a species we have not recognized here.

Prasiola is a genus of distinct forms; we have been able to trace only two species in this country: *P. crispa*, and *P. Mexicana*, Liebm., the latter a larger form collected from rocks in a high mountain stream of Colorado.

Sphæroplea is finely illustrated; hitherto this plant has not been found in the United States.

Among the *Confervace*æ, we consider the genus *Microspora* of no sufficient value to retain the position given it by Thuret. In this connection the author quotes the name of Dr. Kirchner six times but incorrectly with an s—"Kirschner." We think it would have been wisdom to adopt the Doctor's ruling throughout.

Enteromorpha and *Chetomorpha* are marine or submarine plants.

Rhizocloniums do not appear well represented in Great Britain. The cladophoras also, are more numerous with us; finally, *Pithophora*, which seems to have been introduced from tropical climes into the Kew Gardens of London, has a home in the States of Florida, New Jersey, and Pennsylvania. F. W.

NOTES.

—Prof. Koch's experiments on disinfectants show that the most efficient are chlorine, bromine, and corrosive sublimate. A solution containing one part of the latter in 1000 of water will kill fungus-spores in a few moments, and a much weaker solution will cause total arrest of development.

—The second volume of Cole's "Studies in Microscopical Science," promises to be

quite as useful to the general microscopist as the first, which is now complete. The plan of the current volume is somewhat different from the other. It will be in three sections: I. "Physiological Histology," including a description of instruments of research and methods of preparing specimens in the first part, and in the second part a series of histological demonstrations with corresponding preparations. II. "Pathological Histology." III. Botanical Histology." IV. "Microscopical Petrography." Sections II. and IV. will not be published unless a sufficient number of subscribers to pay the cost is obtained.

—On the evening of the 6th of April, the Editor addressed the New York Microscopical Society on the subject of deep-sea sounding and dredging. The subject was illustrated by lantern-transparencies prepared for the occasion. This was the first of two proposed lectures on the subject, and was confined entirely to a description of the apparatus and methods employed in deep-sea investigation.

—What seems to be an excellent arrangement for a fish-trough when it is desired to show the circulation of the blood in the tail of a fish, has been devised by a Mr. Caton. It consists of a conical ebony box large enough to hold the head of a small fish. The box is attached to an ebony plate having a circular plate of glass so that when the fish's head is in the box its tail will be on the glass. Just at the border of the glass the plate is perforated to allow a cord to pass through and over the tail of the fish to hold it securely down. The box is partly filled with water, and two tubes open into it, so that a constant stream of water can be made to pass through it and keep the fish alive for hours or days.

—It may interest some readers, especially those who are studying the diatoms, and would like to find the rare forms that occur occasionally in the stomachs of certain animals, to know that the contents of an oyster's stomach can be withdrawn by inserting a tube through the mouth. If this can be done with the oyster, there is no apparent reason why it cannot also be done with many other animals, and the contents could be far more easily cleaned than when they are obtained by dissection in the usual way.

—In the March number of *Grevillea*

Mr. M. C. Cooke describes a species of *Vaucheria* which, at the time of fructification, becomes divided by septa into cells resembling *Cladophora*. *Vaucheria* filaments are universally regarded as single cells until at the time of fructification a single septum forms, separating the terminal portion from the rest; but these observations of Mr. Cooke—first made by Mr. Frederic Bates—require some modifications of views concerning this plant.

—Sponges used for toilet purposes sometimes become quite black in color by the growth of a fungus of the genus *Torula* which M. Dufour has named *T. spongicola*.

—The *New York Medical Journal* is publishing abstracts of the Cartwright lectures on the Relations of Micro-Organisms to Disease, delivered by Dr. W. T. Belfield, of Chicago, before the Alumni Association of the College of Physicians and surgeons of New York. The abstracts seem to be very carefully prepared and are very interesting as well as instructive.

—The first volume of the *Transactions* of the Linnæan Society of New York has recently been published. It contains a portrait of Linnæus, engraved on metal, as a frontispiece, and three articles, the first on "The Vertebrates of the Adirondack Region;" the second, "Is not the Fish Crow (*Corvus ossifragus*, Wilson) a Winter as well as well as a Summer Resident at the Northern Limit of its Range?" and the third is "A Review of the Summer Birds of a Part of the Catskill Mountains, with Prefatory Remarks on the Faunal and Floral Features of the Region." The first article fills 106 out of the 168 pages in the volume. It is not only an instructive, but also a very readable article, being evidently written by an experienced naturalist and a careful observer—Dr. C. H. Merriam.

The volume contains much valuable information to both the zoölogist and the botanist. It is printed in large type, leaded, on heavy book-paper, small quarto size, and the mechanical work is excellent throughout. Bound in cloth the price is \$3.00, in paper \$2.00.

—Somebody has sent us some card photomicrographs, but we have received no letter informing us from whom they came. Among them is a section of basswood and the foot of a rose-beetle.

CORRESPONDENCE.

ON OBJECTIVES.

TO THE EDITOR.—I quote from your issue of February, p. 28, as follows:—

"Is it possible to throw light on such a confusing subject?"

"Why should a physician who uses a microscope in his practice pay \$35 for one objective while the \$15 one will answer his purpose just as well?"

He would be a fool to do so, but he will never know that, you cannot convince him until he tries both for himself. No man knows for certainty which is best for another man. The enclosed letter from the late Dr. Hoyt, an experienced practitioner who had used for diagnosis and pathology for years the objectives in common use by the profession—shows the difference in results between first quality and \$15 lenses, and throws some light on this confusing subject.

CARL REDDOTS.

[COPY OF LETTER.]

"To-day I had for examination a specimen of urine that contained albumen, and casts almost invisible with common objectives. This evening I have been looking at them with the $\frac{1}{10}$ [Tolles 180°]. It shows them splendidly and leaves no doubt of their nature. It is just what every physician needs who does not wish to grope in the dark."

[We do not print the above correspondence for the purpose of controversy; but because we are well aware of the influence of reiterated dogmatic assertions, even when they are demonstrably erroneous. Not every one who is interested in this subject—and all who purchase objectives are,—has the opportunity of submitting the matter to a test. Nor is it necessary that he should. One has only to look at the work that has been done in the past, before excessive angular apertures were used at all. What does the writer mean by saying "No man knows for certainty which is best for another man?" Either what is good for one man is good for another for the same purpose or else we have no criterion of excellence. The reason the argument of our correspondent is inconclusive and unsatisfactory, is simply that the facts offered in support of it are not accepted. It is absurd to say that hyaline casts—no matter how hyaline they may be—

can be better examined with a lens of high angle than with a good objective of moderate angle. It is an old and rather worn out claim, which needs no refutation except such as anyone can gain by a little experimenting.—ED.]

TO THE EDITOR.—"M. A. B." who has a large exchange-list, should tell from where the damaged slides come, to warn others. During the eighteen months in which I have exchanged I have yet to receive a broken slide, or to hear of one broken that I have sent out.

I use the wooden boxes, and when I send out slides I send stamps to pay for the return of the empty boxes, which costs about one cent for each box of six slides. I use tissue paper which I wrap around the slides several times until it fits very tight into the grooves in the box, so tight that the slides have to be forced in with some pressure. "M. A. B." should try this way.

T. C.

RICHMOND, Va.

A WORK-TABLE.

TO THE EDITOR.—As universally recommended, I have been in the habit of keeping my microscope under a large bell-glass. The largest I could find out here would barely cover the instrument and the bulls-eye condenser, thus requiring the other articles to be put away out of the dust when not in use. The bell-glasses are costly, and easily broken. I finally had a box arrangement made on top of my work-table. Its internal height is 18 inches. There are two strong uprights let through the top and screwed to the hind legs of the table. The back is stationary, and is screwed on the outside of the two uprights; the sides swing by hinges from the back; the top is also hinged to the back and opens upward, and the front is in turn hinged to the top. The sides are tongued to fit into grooves in the top and front. Some small shelves are arranged against the back.

T. B. JENNINGS.

A CORRECTION.

TO THE EDITOR.—Will you kindly allow me space for the correction of two or three errors which I have noticed in my paper on the "Conditions of Success in the Construction and the Comparison of Standards of Length," read at the Elmira Meeting of the American Society

of Microscopists and printed in the *Proceedings* :—

On page 247, for *increase* read *decrease*.

On page 240, in the approximate rule given for computing the probable error of a single observed value of a given series, the coefficient two-thirds was inadvertently omitted, and the results obtained should have been $\pm 0.24\mu$ and $\pm 0.08\mu$ instead of the values given.

The following are the more exact formulæ for probable errors :—

$$r = .6745 \sqrt{\frac{[\tau^2]}{n-1}} \quad (a)$$

$$r_o = \frac{r}{\sqrt{n}} \quad (a')$$

in which

n = the number of values of a given function x .

v = the difference between each value of x and the arithmetical mean of all the values.

$[\tau^2]$ = the sum of the separate residuals without regard to sign.

r = the probable error of a single value.

r_o = the probable error of the arithmetical mean.

Nearly equivalent formulæ have been developed by Peters, which are rather more convenient in application.

They are :—

$$r = .8453 \sqrt{\frac{[v]}{n(n-1)}} \quad (b)$$

$$r_o = .8453 \frac{[v]}{n \sqrt{n-1}} \quad (b')$$

For convenience of reference the example given on page 240 is here repeated.

<i>Residuals.</i>		
x	v	vv
1000.0 μ	0.4	.16
1000.2	.2	.04
1000.1	.3	.09
1000.6	.2	.04
1000.5	.1	.01
1000.9	.5	.25
1000.0	.4	.16
1000.4	.0	.00
1000.3	.1	.01
1001.0	.6	.36
Mean 1000.4	$[v] = 2.8$	$[\tau^2] = 1.12$

According to (a) and (a')

$$r = \pm .6745 \sqrt{\frac{1.12}{10-1}} \mu = \pm 0.24\mu$$

$$r_o = \pm \frac{0.24}{\sqrt{10}} = \pm 0.08\mu$$

According to (b) and (b')

$$r = .8453 \sqrt{\frac{2.8}{10 \times 9}} \mu = \pm 0.25\mu$$

$$r_o = \pm \frac{.25\mu}{\sqrt{10}} = \pm 0.08\mu$$

The quotient obtained by dividing the difference between the greatest and the least values of a given series by 3.8 will give a rough approximation to the value of r .

In this case we shall have :—

$$r = \pm \frac{1.0}{3.8} \mu = \pm .27\mu.$$

W. A. ROGERS.

MICROSCOPICAL SOCIETIES.

The Microscopical Society of CENTRAL ILLINOIS met on Feb. 15th, and after the transaction of routine business listened to the reading of the second section of T. B. Jennings' paper on "Animal Life in the Reservoir-Park Waters." This section treated entirely of the *Amœbæ* found there, the first part, however, being a technical description of what constitutes a *Rhizopod*.

The WELLESLEY COLLEGE Microscopical Society is still actively engaged in work for the mutual instruction of its members. At one of its meetings not long ago the general subject, "Ehrenberg and his Work," was brought forward by several members. Miss Tyler read an article on "Microscopists before Ehrenberg." Miss Dunbar another on the "Life of Ehrenberg" and Miss Luce spoke on "The Works of Ehrenberg." This plan of designating certain members to prepare articles treating of specified parts of a subject, seems worthy of imitation in many other societies. We

also notice articles presented on Seeds, Algæ, Mosses, Reagents and their Use, The Life of Darwin, Darwinism, and other subjects. Prof. W. B. Carpenter was present at one of the meetings, and Prof. W. A. Rogers on another occasion, spoke on the subject of ruling lines on glass.

NOTICES OF BOOKS.

Annual Report of the Chief Engineer of the Water Department to the City Council of Wilmington, for the year 1882. Wilmington, Del.: The James & Webb Printing and Stationery Company, 1883. (Pamphlet, pp. 48, 83, 88.)

This report contains also a report by Prof. Albert R. Leeds on the water supply of Wilmington, including analyses of waters from Brandywine River and from other streams, and another report by Prof. Ira Remsen on some analyses of waters.

Annual Address delivered before the American Academy of Medicine, at Philadelphia, October 26th, 1882, by Trail Green, A.M., M.D., President of the Academy. Philadelphia: 1883. (Pamphlet, pp. 16.)

The subject of the address was "A Retrospective Glance at the Origin and Progress of the Academy."

Notes on American Parasitic Copepoda. No 1. By R. Ramsay Wright, M.A., B. Sc. Professor in University College, Toronto. (Pamphlet, pp. 12, with 2 plates.)

This is a collection of notes on three species with full descriptions, two of which are new, with carefully drawn illustrations of different parts and organs.

Report of the Commissioners on Investigation of Water Supply of the City of Boston. [Document 129—1883.]

This is a pamphlet of 186 pages, embracing full reports of the testimony of engineers, scientific men, and private citizens concerning the condition of the water-supply of Boston and the cause of its contamination. It is a very useful document for reference for any person

who is engaged in studying the water-supply of towns, for the opinions of competent observers are given in the form of detailed reports of examinations before the Commissioners.

The Percentage of College-bred Men in the Medical Profession. A paper read before the American Academy of Medicine, at its Annual Meeting in Philadelphia, October 27, 1882. By Charles McIntire, Jr., M.D., of Easton, Penn. Printed by Order of the Academy. Philadelphia: 1883.

The Storage of Electricity. By Henry Greer, Member of the New York Electrical Society, American Geographical Society, etc. Illustrated. New York: College of Electrical Engineering. (Pamphlet, pp. 42, price \$1.00.)

This seems to be a useful compendium of knowledge relating to the subject of storing electricity, which has become of great importance during the last few years.

Exchanges.

WELL-MOUNTED slides of Polycystina, transparent and opaque, for any well-mounted slide. P. C. Cole, M.D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 103 Virginia St., Richmond, Va.

DIATOMACEOUS MATERIAL and Histological slides for other well-mounted and named slides of Foraminifera, Animal Parasites, Pathological subjects, etc. R. Cauch, M.D., Carpenteria, Cal.

SECTIONS: Kitten's Jaw, teeth *in situ*, in exchange for first-class slides. Jay L. Smith, 86 Beekman St., New York City.

Fossil DIATOMS from Carson, Nev., and Fosa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

FOR SLIDES of Diatoms from the Wabash & Erie Canal at Ft. Wayne, send any well-mounted slide to H. C. Tresselt, Fort Wayne, Ind.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

VOL. IV.

BOSTON, MAY, 1883.

No. 5.

Photomicrography.*

This being one of a series of demonstrations, and not a lecture, it is not my desire to occupy your valuable time and attention by making more than a few preliminary remarks neces-

in the first place remind you that I do not stand here as an oracle on the subject, but simply come before you at the wish of the higher powers of the club to do what I have so often done before, and that is to stop a gap which might have been filled by others

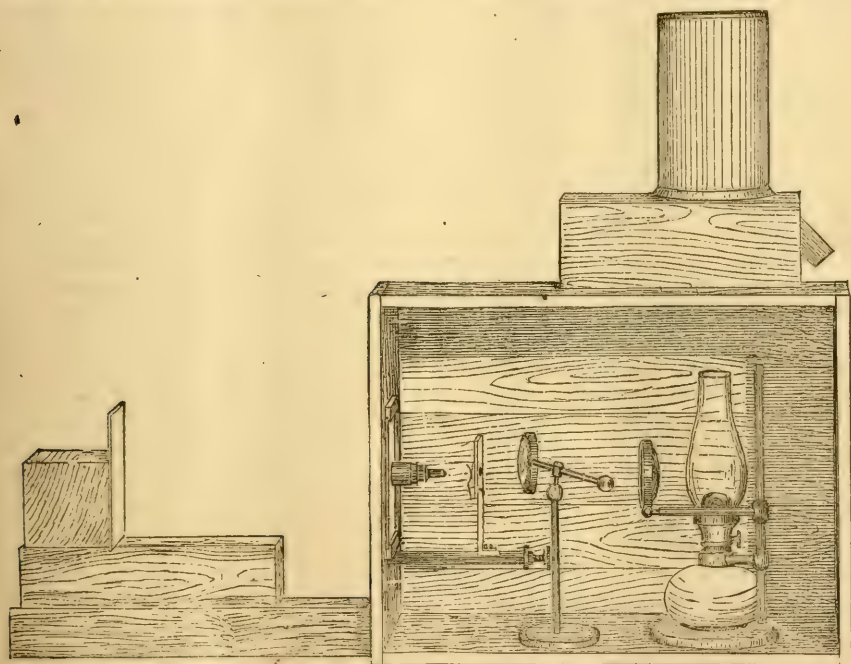


FIG. 16.

sary to your fully understanding those essential details in the art of photomicrography which may serve to start you fairly in this very interesting occupation for winter evenings. I would

more efficient but, at the same time, more modest. It is a very true saying "that if the blind lead the blind, shall they not both fall into the ditch?" Now, it is far from my intention to land you with myself in this ignominious dilemma. I shall only show you the method I have employed for my

*A paper read before the Quekett Microscopical Club.

own recreation ; and if any of you like to follow my steps you may be able to introduce many improvements, and serve to advance the art, which has many fascinating charms about it for the enlightened worker.

It has been often asked by numbers of those fossilized individuals who may be found in great abundance, "What is the good of making photographs of microscopical objects? It has been tried over and over again and found no good ; it can't be done." To such I would reply :— If you found yourself knee-deep in one of those floating bogs which the sportsman and traveller may often unwittingly step upon in Ireland and elsewhere, would you attempt to run and get out of it as quickly as you could, or would you stand still to sink for ever in it because hundreds of others had tried to run, but had generally sunk to be seen no more? I reckon that you would "make tracks" to get out as well as you could ; and this illustration may be used as an argument in advocating the further study of this art. It is not because our predecessors have been, as it were, floundering about in the practice of photomicrography that we are to rest content ; but I deny entirely the assumption that they did nothing worthy of our admiration, or sufficient to encourage us in our endeavors after perfection. I grant that the art is surrounded by many and great difficulties, and only the application of close study and the concourse of many minds can tend to its advancement ; but while it is neglected or limited to a few practitioners its advance must be slow.

I am glad to see by the photographic journals that many in the provinces and abroad are awakening to the interest attached to this process, and much good will result. I must, however, proceed to the subject of this evening's demonstration. The method most generally practiced and recommended is that the microscope being placed in a horizontal position, its tubes should be attached by a blackened

tube or a cone to the front of a photographic camera, the lens of which has been removed. Now, I find these difficulties arise. It is not every one who has got a camera, and they may not feel disposed to go to the expense of procuring one, while all the members of this club possess microscopical objectives ; but, further, if they have a camera, it is not an easy matter to see the fine details of a subject through the ordinary ground focussing glass. Again : unless the camera and microscope are securely fastened down to a base-board there is a tendency to unsteadiness which is irritating in the extreme ; and, furthermore, this usual plan does not offer any advantages over that I wish to introduce to your notice this evening. In the apparatus before you, and which I have found so convenient, it is not necessary to have either a camera or a microscope, and it is so simple that it can be adopted by the youngest member of the club ; but, even with this, difficulties will arise which are altogether apart from the apparatus. For instance ; objects differ in their capability of transmitting the actinic rays ; they may be too opaque or brown, or they may be stained blue or red. All these conditions vary the time of exposure, only experience teaching the requisite time to imprint the image in the sensitive film just sufficiently without under or over-exposure ; this must be left to the cultivated judgment of the operator. Great assistance will be derived by the beginner sticking to one objective till he can produce a good result on every occasion, when another may be tried, the time of exposure being greatly varied by the magnifying power employed, the lower powers admitting of a shorter exposure as more light passes through them. The principles upon which this beautiful art is founded may be read in any of the many manuals on photography, and which are published at a cheap rate ; therefore, leaving these, I will pass on to the practice. If any one need to learn about the

various apparatus employed for photomicrography, full particulars will be found in Beal's "How to Work with the Microscope," and in Cutter's "Microscopical Technology," both of which works are in our library.

In the first place, I claim for my plan its great simplicity, being as you see, (fig. 16) nothing more than a lidless box placed on its side. At the left end it has a square hole; but any aperture will do. A brass plate, having an adapter in it, slides in and out on runners for more easily changing the powers when it is desired to do so. Another long aperture is made at the top side, covered by a blackened chimney to carry off the heat from the duplex paraffin lamp inside. Another aperture at the bottom of the right side serves to admit the air to the lamp when the front of the box is covered up by the black focussing-cloth; within the box, and attached to the left side, is a carrier working on a long and fine screw, which serves to adjust the object to the correct focus. Two condensing lenses—one to render the rays of the lamp parallel, and the other to condense them on the object—complete the arrangement as far as the box is concerned. The light passing from these through the objective emerges as a cone, and on the principle of a magic lantern projects the image on a screen to the left of the operator.

The screen consists of a heavy piece of wood having a groove formed in it, and carrying another block upon which the screen is held. The screen which receives the image may be made of an oblong piece of glass either four and a quarter inches by three and a quarter inches, called by photographers a quarter-plate, or by a plate 5×4 , according to the amplification you intend to employ or the nature of the object may indicate or, if lantern slides are desired, on a square three and a quarter inches. These ought to have a piece of smooth writing paper gummed on that surface presented to the image. The image

is then thrown on to one of these, and the hand placed under the focussing-cloth, the carrier is to be moved by means of the screw adjustment till the image of the object is sharply defined on the screen.

In many writings on this subject it is stated that the actinic and visual focus of microscopical objectives are not coincident. All I can say is that, with a one-third of an inch, which I shall employ this evening, and with Zeiss's D, no alteration is needed from the visual focus. The screen may now be removed, and its place occupied by a dry gelatine plate, and the exposure accurately timed according to the nature of the object; but only experiments can determine this. Care must be taken before making the exposure that the light through the objective be cut off till the plate is in position, when it may be allowed to fall on the plate for the requisite time, and then cut off again before removing the plate to the developing dish; this is done, as must be evident to you all, to avoid blurring the image. I need not say that the only outside light must be a non-actinic red light, and no ray of white light must be allowed to reach the plate, or it will be "fogged"—that is, when it is developed it will be veiled by a misty deposit in the film; therefore no actinic light is admissible till the plate is fixed.

The developer I use is the ferrous oxalate, made by a saturated solution of protosulphate of iron added to a saturated solution of neutral oxalate of potash in the proportion of one part of the iron to the three parts of the oxalate; these are best when freshly mixed. If the plate has been rightly exposed the image begins to make its appearance in about forty seconds, and grows under the action of the developer till it is full of detail. When the image shows faintly through the film on looking at the back of the plate I stop the development, and wash the plate by a good rinsing in rain or distilled water, and then place

it in the fixing bath, which consists of a solution of four ounces of hyposulphite of soda dissolved in a pint of water; this extracts all the silver which has not been acted upon by the light. The plate must now have a great deal of washing to rid it of the hyposulphite of soda; this is thoroughly done by placing it in running water under a tap for half-an-hour. If the film contains a trace of hyposulphite it causes the image to fade out after a time.

Some plates have a tendency to frill, that is, the edges of the film gelatin, while wet, have a tendency to separate from the glass and to curl up. To prevent this the plate may be soaked for about five minutes in a saturated solution of alum, and then again well washed and stood up on a sheet of blotting paper to dry spontaneously.

Now I have thought it well, before commencing the demonstration, to give you these details, that you may, bearing them in mind, follow the practical part with a clearer understanding of what I am doing and why I do it, and at the same time the box and its brass contents have been getting warm—a not unimportant item in the proceedings; for if you begin your operations before this takes place your glasses will become dewed with the moisture condensed on them, your brass will be in a process of expansion from this heat, your image will accordingly be wanting in definition, and your plate assuredly spoiled. I will now proceed to photograph the blow-fly's tongue.

T. C. WHITE.

Instructions in Dry-Plate Photography.

BY THE EDITOR.

The object of these articles is to enable the reader to make good photographs with the microscope, and to prepare lantern-transparencies for use in illustrating articles read before societies, or public lectures.

In the preceding volume of this JOURNAL several articles were published on the subject of photographing from the microscope with dry plates. It is not proposed to repeat much of what was then published on this subject, but rather to supplement those articles by some further instructions and suggestions which later experience has shown to be of value. The mechanical arrangements for photographing with the microscope have already been described.* The ingenious apparatus illustrated in the figure, although somewhat more expensive than the apparatus previously described, leaves nothing to be desired as regards convenience and ready use. The lantern is a most excellent one, suitable for all purposes of the photographer. It has on one side a plate of ruby glass to afford a non-actinic light for developing dry plates. On another side there is a plate of porcelain to afford an even white light for copying. There is no better lantern to be found, but its cost will lead many to select a much cheaper one to use in the dark room for developing, and use a student-lamp as the source of light for taking the picture.

In this article it is proposed to give full instructions for developing and finishing negatives, glass positives and paper prints. The formulæ for preparing solutions can be relied upon absolutely. Not one but we have personally used with satisfaction will be given—in fact they are all the identical formulæ we have used in our own work. It may be laid down as an indisputable fact, that by following the instructions intelligently, any person can succeed in making excellent photographs with dry plates.

As regards the brand of plate used, we have found Carbutt's plates uniform and satisfactory. But it makes very little difference what plates are used. Not that the products of different makers are alike, for they are not; but all are good, all will yield

* Vol. iii. pp. 71 and 88.

excellent results. We would as willingly use one brand as another; for the differences in sensitiveness and in development are of little consequence, if one works intelligently in the dark room. We would advise the use of slow-working plates, however, whenever great rapidity is not absolutely required. The demand for rapid plates has led manufacturers to vie with each other in producing the most sensitive plates possible. These are mainly called for by amateurs in field photography, and for in-door work in studios.

In passing to such extremes the art in the work is sacrificed. To obtain fine gradations of light and shade, time must be given to the plate in the camera. For this reason we have preferred slow plates for landscapes, and never would use a quick plate except for instantaneous views. For photomicrographs we have used the "B" plates of Carbutt.

EXPOSURE.—The exposure should be just long enough to give all possible detail in the shadows, and at the same time long enough to give density in the high-lights. To the novice this sentence will require some explanation, and it is essential that it be fully understood if one would work intelligently. To explain it we will suppose the subject is a landscape, because we can the more readily use such an example than a microscopic specimen which might not be familiar to every reader.

In a landscape, the sky is the brightest object of all. The sky should print white, hence on the negative, where the lights and shadows are reversed, the sky must be black. The intensity of the negative representing the bright parts of the object will depend upon the exposure that has been given. But the strong light of the sky impresses the sensitive plate very quickly and strongly, and a very short exposure gives an opaque sky.

But when we consider the shadows and dark objects in the landscape, it will be seen that there are gradations

of light and shade, all of which must be impressed upon the plate. In order to get them the exposure must be so timed that the comparatively weak light reflected from such objects can act upon it. Obviously this requires a longer time than the high-lights, hence when the dark parts are properly exposed, the sky is over-exposed. For this reason, the clouds do not show in a photograph,—the entire sky prints perfectly clear, no matter how many clouds were visible when it was taken. From this it will be correctly inferred that the exposure must be timed to correspond to the dark parts of an object, regardless of the rest; for the details, either of light and shadow, or of texture or structure, must be brought out in the dark portions.

This is especially necessary to consider in microscopical work. We have seen many photographs of microscopic objects which showed the outlines distinctly, but in which detail was quite wanting. Take almost any preparation of a large insect—the proboscis of a bee, or the sting, for example—and make several photographs with different exposures, and the results will afford a good idea of the time necessary for the yellow and reddish parts to be properly impressed on the plate.

DEVELOPMENT.—After the plate has been exposed the image is invisible, and has to be brought out by the developer. The composition of the developer will be given further on. Suffice it here to say that the developer causes all parts of the plates which have been acted upon by light to turn black, leaving the rest white. It is during the process of development that the operator learns whether the exposure has been about right or not. If the image flashes out quickly, the plate has been over-exposed; if it develops very slowly, under-exposed. The books say that a negative from an over-exposed plate is weak, and lacks contrast, while an under-exposed plate

gives exaggerated contrasts. Nevertheless, the novice is frequently puzzled to decide whether a plate is over-exposed or under-exposed, when it is evident that something is wrong about it. In this case, as in all others, an understanding of their peculiar effects will be of some assistance.

In the case of an over-exposed plate, the light has acted so long that the parts of the plate which should be unchanged have been affected, while in the high-lights the silver salt is so changed that it is impossible to obtain intensity by development. Over-exposure is not so noticeable when a plate is developed with the ferrous oxalate developer, as when an alkaline pyrogallic developer is used.

In an under-exposed plate the strong contrasts are due to the insufficient light from the shadows, so that while the strong lights are black, all the dark parts of the object are white in the negative without the gradations that they should have.

To a certain extent the operator can control the development of the plate, and remedy the defects of incorrect exposure. This is done either by changing the strength of the developer, or by the addition of chemicals to counteract the effect of the light. Such chemicals are designated restrainers. We now pass to the practical operation of development.

From among the numerous developers in use we will only give those which we have used and found satisfactory.

Looking through the photographic literature of the day it would seem that a large proportion of those who are engaged in photographic work, either as amateurs or professionally, deem it a bounden duty to get up new developers, which, in most cases, are merely modifications of old and well known formulas. We have done the same thing with the pyrogallic acid developer, but not with any intention of improving the formula for work. Our object has been to obtain concentrated stock solutions which will keep

for any length of time, from which the working solutions can be made by dilution. Mr. J. T. Taylor has also published a formula for a concentrated developer in the *Photographic Times*, which is virtually the same although not so strong as our own.

The solutions we have used are the following:—

A. Concentrated Pyrogallic Acid Developer.

Pyrogallic acid,	120 grains.
Oxalic acid,	60 grains.
Water,	2 ounces.

Half a drachm of this solution contains nearly 4 grains of pyrogallic acid.

B. Saturated solution of Washing-soda.

C. For a restrainer we use ammonium bromide (or potassium bromide) 50 grains; water 1 ounce.

To prepare a solution for developing a plate, take half an ounce of B. and add to it two ounces of water. Then take half a drachm of A. and add it to two ounces of water. Mix equal parts of these two solutions and use immediately. In practice we have two bottles for holding the diluted solutions, and we make up about five ounces of each at one time, as they will keep perfectly well. We develop in developing dishes that will take a 5 x 8 plate, and when using 4 x 5 or smaller plates it is frequently possible to develop two of them together. Such a pan requires about an ounce of each solution for each operation. The solution thus prepared is the same as that lately introduced by Mr. J. H. Newton, and already favorably known.

There is another developer very extensively used in this country known as the ferrous oxalate developer. A good ferrous oxalate developer may be prepared in this way:—

1. Potassic oxalate, neutral,	8 oz.
Potassium bromide,	25 gr.
Water,	32 oz.

Acidify with citric or oxalic acid, until it turns blue litmus paper red.

2. Ferrous sulphate (green

vitriol),	2 oz.
Water,	8 oz.

Acidify with a drop of sulphuric acid to each ounce of water. To make the developer, add one ounce of No. 2 to five of No. 1.

The ferrous oxalate developer can be used until it ceases to give vigorous images, and even then it may be rejuvenated by the addition of a few grains of powdered sulphate of iron. The fifty-grain solution of bromide should also be at hand while developing with the ferrous oxalate, to use in case of over-exposure.

For negatives we prefer to use the pyrogallic developer, as it seems to give a finer deposit on the negative than the oxalate. The latter, however, is very highly esteemed by many persons. The former is the cheapest developer known.

The pyrogallic developer is capable of great changes in composition to meet different circumstances. Bear in mind that the addition of more soda accelerates the development; increase in the proportion of pyrogallic acid gives greater density. Therefore, for an under-exposed plate the solutions may both be made a trifle stronger with benefit. The use of soda tends to loosen the film of gelatin from the plate, so development should not be very slow while using this solution.

The ferrous oxalate may also be changed to suit special requirements. Thus, for an instantaneous view requiring very strong development, take an ounce and a half of the solution of potassic oxalate, and just before using add 30 grains of ferrous sulphate in powder. The above will do for a 4 x 5 plate.

We will now suppose that an exposure has been made, and that the plates are to be developed. Development must be conducted by ruby light, dry-plates being acted upon by the yellow light used by photographers who work with wet-plates.

Pass into the dark room, arrange the ruby lantern so as to throw the light over the developing pan, place the exposed plate, sensitized side up, in the latter, then mix the solutions of soda and pyrogallic acid and flow them over the plate. Have the solution of bromide at hand for immediate use in case of need. If it is thought the exposure was about right, add two or three drops of the bromide to the mixed developer. If the image comes out too fast, showing an over-exposed plate, add to the developer several drops more of the bromide solution (2-8), to act as a restrainer. A druggist's dropping tube with rubber top is excellent for this purpose.

Watch the development with care. The difficulty the beginner meets with is to know when to stop the process. It must continue until all the details are developed. Never mind the dark shadows or the high lights, but look at those parts where detail is to be sought for—where the gradations of light and shade are delicate and very fine. Soon the developer begins to act at such places, and if the detail is fine the plate darkens and all the detail is obscured. Apparently the picture is spoiled.—But the process is not yet done. Lift the plate up, and look at it from the under side. The general features of the picture must be seen there, and the details must be indicated by the darkening of the film more or less throughout, before the development can be regarded as done. The appearance of the developed plate as seen from beneath will depend upon the thickness of the sensitized film. The operator will soon learn how to treat the particular brand of plates he uses.

Ferrous oxalate development is conducted in precisely the same way.

If the development has progressed properly, as soon as it is judged to be complete wash the developer off under a tap, or by plunging it into a vessel of water. The pyrogallic developer stains the fingers, and as it can only be used once it is best to pour away

the solution after it has done its work and proceed with the washing in the developing pan. This avoids soiling the fingers.

Ferrous oxalate is used repeatedly, so lift the plate out and wash it in the hands.

As soon as the developer is washed out the plate can be taken out into the light, and all subsequent operations can be conducted in daylight, at any convenient time. If the weather be warm, however, there is danger of frilling, that is, of ruffling of the film from the glass. To avoid this the plate may be placed in a saturated solution of alum for a few moments, and then thoroughly washed. After that it may be kept indefinitely, either in water or dry. It is desirable, however, to finish the plates without permitting them to dry. If there are no signs of frilling when the developer is washed off, proceed as follows: When ferrous oxalate has been used for developing, place the plate in the fixing solution, composed of one ounce of sodium hyposulphite dissolved in 4 ounces of water. This dissolves the silver salt from the film, and so fixes the picture. The fixing is completed when there is no white or opalescent appearance to be seen by looking at the under surface of the plate.

Wash the plate thoroughly under a tap, or by soaking, until the hyposulphite is entirely removed. Then place it for five minutes in a saturated solution of alum, wash again, and then stand it up to dry.

After development with pyrogallic acid, the gelatin film is found to be of a yellow color, which is very objectionable. There are several methods of removing the color, the most common being the use of a solution of alum containing some acid—citric, oxalic, hydrochloric or sulphuric—either before or after fixing. We have

found the most effectual means to be the use of a solution of 2 drachms of oxalic acid in 10 ounces of water, immediately after washing off the developer. The plate may remain in this solution five or ten minutes, after which it is washed and fixed. We have not found it necessary to use alum after the oxalic acid, but in warm weather it may be required.

(To be Continued.)

A New *Daphnia*. (Fig. 17.)

In the summer of 1879 I found in the waters of Fox River, Appleton, Wisconsin, a *Daphnia* which seems to have escaped notice hitherto, and which certainly is not figured in any of the descriptions of the Entomostraca of this country.

As will be seen by the figure, its

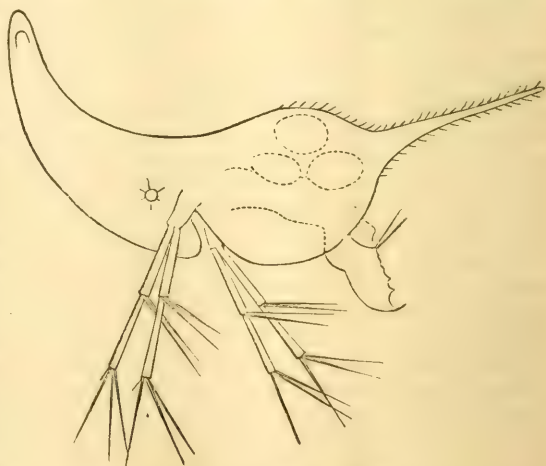


FIG. 17.—DAPHNIA KERUSSES.

peculiarity is a remarkable helmet-like enlargement of the head, curved backward with a broad thin blade or crest. The figure was drawn by Camera, and the specimen was not different from its fellows which were abundant in the river and mill-race near the city. On submitting the drawing to Prof. S. I. Smith, he gave the opinion that no similar species had been described in

this country, and that those figured by European naturalists which most nearly approached it, lacked the symmetrical shape of the enormous falchion crest, and its singular characteristic curve. Those most nearly approaching it in the European species were *Hyalodaphnia Kahlbergiensis*, and *H. Cederströmii*, described by Schoedler in *Archiv für Naturgeschichte*, 1866. As I have found no notice of this species given by other observers up to this time, it seems well to call attention to it by publication of the sketch. As the name of *Daphnia Galeata* has already been appropriated, I have provisionally called this *D. kerusses*.
J. D. C.

Vibratile Cilia and Ciliary Motion.

(Continued from page 75)

EFFECT OF TEMPERATURE CHANGES, ELECTRICITY AND VARIOUS REAGENTS UPON CILIARY MOTION.—In considering the effects of changes in temperature, electricity, and various reagents upon ciliary motion, I have endeavored to avoid a confusing mass of details by tabulating the results of numerous experiments, confining myself to a few general remarks.

In general, the limits of temperature within which ciliary movement takes place are from 0° to 45° C. Within these boundaries the effect of increasing the temperature is to hasten, of lowering, to slow the movements. In every case there is a certain temperature,—the *optimum* which, having been reached, the movement seems to continue indefinitely at the greatest rapidity and with the highest energy. This *optimum* is always some degrees below the maximum; if it be overstepped the motion becomes temporarily exacerbated, failing after a time, the sooner, the nearer the temperature is to the maximum. While cessation of movement takes place on the temperature reaching the maximum (45° C.) it may be revived if the temper-

ature is not maintained too long, but if the cell be warmed a few degrees higher than the maximum, to the ultra-maximum (about 48° C.), death immediately takes place. In this case the cells become turbid through coagulation of the albumen. The effects of changes of temperature on ciliary motion correspond very well with the effects of like changes upon the movements of bacteria, as established in the culture experiments of Drs. Wood and Formad.*

There seems to be no specific poison for ciliary movement, excepting, perhaps, in those cases in which it seems to be under the influence of the will, as when it serves for voluntary locomotion. Generally, however, there is no direct influence of the toxic substance upon the cilia through the substance of the ciliated cell.

Regarding the effects of electric currents, we find great difference in the various forms of ciliated cells. Thus, the larger cilia belonging to the branchial laminae of bivalves behave towards electrical irritation much like muscle, bending themselves with a jerk, after an induction shock towards the front, and remaining in this position as in a cramp, the longer the stronger the irritation.

The thermic nature of the influence of the electric current is proven by Engelmann, who shows that, with a single exception, the rules governing the effects of electricity upon vibratile cilia are the same as with other electrically irritable elements.

VIBRATILE CILIA AND CILIARY MOTION IN THE VEGETABLE KINGDOM.—The phenomena of ciliary motion as exhibited in the animal kingdom are familiar to every student of biology. It is not so generally understood,

* Micrococci multiply best at from 37°–40° C. Higher temperatures up to 70° C. do not destroy them, but only partially arrest their multiplication which returns if the 70° is again reduced to 40° or 35°.

Fungi, other than Micrococci, perish at a temperature above 50° and proliferate well only at 30° C, and below.

ACTION OF VARIOUS REAGENTS ON VIBRATILE CILIA.

REAGENT EMPLOYED.	STATE OF REAGENT	EFFECT ON MOVEMENT.	ANTIDOTE.	EMPLOYED BY
<i>Water.</i>	Fresh.	Swelling and rapid destruction of such cilia as are normally bathed in salt water: not so marked if added gradually. Destroys movement of spermatozoids.	Sodium chloride, salt, sugar, alum, (concentrated sol.).	Engelmann. Köl liker, (ref. 83).
"	"	Stimulates at first, heightens electromotor power and finally destroys movement.	Crystalloids, evaporation, sugar, glycerine, CO ₂ acetic acid, ether.	Engelmann. (ref. 13, 17).
<i>Blood.</i>	"	Destroys in invertebrate cilia. Very favorable for the study of, in mammals, birds and reptiles.	Ether (sometimes), caustic sodium or potassium.	Sharpey, (ref. 44).
Iodized Serum.*	"	Most favorable for study of movement in general.		"
<i>Bile.</i>	"	Arrests.	None.	"
<i>Albumen and Milk.</i>		Conservates.		"
<i>Sodium Chloride.</i>	0.05%	Very favorable for observation.		Köl liker, (ref. 83).
"	0.5%	" " "		Roth, (ref. 75).
"	4% 5%	Maintain for a long time.	Revived when it does cease, by caustic soda and potash.	Engelmann. (ref. 17).
"	Over 6%	Destroys.	(Sometimes) dilution or CO ₂	Leutmeyer, (ref. 59).
<i>Sodium Phosphate.</i>		Especially favorable. Stimulates at first, then destroys.		Köl liker, (ref. 80), " 83).
<i>Alkalies (in general).</i>	Dil.	Are favorable to movement in spermatozoids.	Heat.	Virchow, (ref. 55). Köl liker, (ref. 83).

* Iodized Serum is the Amniotic fluid of ruminants, to which has been added a little conc. tinct. iodine.

ACTION OF VARIOUS REAGENTS ON VIBRATILE CILIA.—*Continued.*

REAGENT EMPLOYED.	STATE OF REAGENT.	EFFECT ON MOVEMENT.	ANTIDOTE.	EMPLOYED BY
NH ₄ Ho, etc.		Heighten electromotor power.	Uninjuriously gases, air or neutralization if not too advanced.	Engelmann, (ref. 17).
"	Conc.	Cause swelling and cessation.		Kölliker, (ref. 83).
Caustic Potash.	$\frac{1}{32}$ — $\frac{1}{50}$ % $\frac{1}{40}$ %	Excites motion in spermatozooids. Stimulates.		" A. de Quatrefages. Virchow, (ref. 55).
Acids (in general).	Conc.	By coagulating albumen they mechanically cause turbidity, swelling and death.	Neutralization in early stages.	Engelmann, (ref. 13, 17).
"	Very dil.	Stimulates.		"
Hydrocyanic Acid.	10 %	No special toxic effect. Instantly destroys.	None.	" Sharpey, (ref. 44).
Chromic Acid.	$\frac{1}{1000}$	Stimulates at first, then gradually destroys.	Alkalies.	Hannover, Stuart, Cl. Bernard, Kühne, Englemann, etc., etc.
Hydrochloric Nitric, Sulphuric, Formic, Acetic, Lactic, Oxalic.	}	If very dilute, stimulates. If concentrated, destroys the movement mechanically by coagulating albumen of cell, and dissolves cilia.	None.	Engelmann.
Anæsthetics (in general).		Weaken electromotor power.	Pure air.	"
Alcohol, Ether, Chloroform, Nitrite of Amyl.	}	If very dilute, stimulates. If concentrated, destroys movement and produces turbidity. Chloroform leaves the least injurious effects.	Air, or alkalies if not left more than 20 minutes.	Virchow, Kölliker (ref. 83), Valentin, (ref. 54), Cl. Bernard, (ref. 67).
Air.	Pure.	Destroys gradually, but may be revived after pressure of eight atmospheres.	Caustic sodium, " potassium.	Tarchanoff, (ref. 78). Englemann. (ref. 17).

ACTION OF VARIOUS REAGENTS ON VIBRATILE CILIA.—*Continued.*

REAGENT EMPLOYED.	STATE OF REAGENT.	EFFECT ON MOVEMENT.	ANTIDOTE.	EMPLOYED BY
<i>Oxygen.</i>	<i>Pure.</i>	(Entire absence not immediately fatal.) Destroys sooner than air.	May be revived after pressure of 8 atmospheres.	Kühne, Tarchanoff, (ref. 77-8).
<i>Hydrogen.</i>	"	Destroys gradually.	Oxygen and alkalies if not left too long.	Kühne, (ref. 73).
<i>Ozone.</i>	"	Acts somewhat like Hydrogen. First stimulates, then depresses.	None.	Hürzinga, (ref. 71). Engelmann.
CO ₂	"	Destroys in two minutes.	Alkalies, air, oxygen.	Leutmeyer, (ref. 59).
"	Dil.	Maintains longer than air.		"
Veratria, Physostigma Curare,* Strychnia, Atropia, Eserina, Morphia,† Quinia.	}	When given internally have no effect upon cilia. Act like acids or alkalies, depending on the chemical characteristics of the solution, and have no more effect than other substances of like osmotic qualities, and reaction on cilia placed in their solutions.		Purkinji, (ref. 52). Valentin, Engelmann, (ref. 13).
		Destroys, and cell rapidly dies.		
Carbolic Acid.		Inhibits, but does not destroy cell life.		Prudden, (ref. 74).
		Causes nucleus to shrink, and brings out a wedge-shaped, sharply outlined network extending from the ciliary border to the nucleus.		
<i>Heat.</i>	30° C.	Stimulates.		Roth, (ref. 38, 85). Calliburces, (ref. 68).
"	28° C.	Movement becomes six times as fast as when at 12-19° C., then ceases, and cell shrinks and becomes cloudy and yellow.		"

* Excites the movement of seminal elements "in an exquisite manner." (Von La Valette St. George.)

† Morphia sulph. like cocaine has no action on the motion of spermatozooids. (Wagner, Külliker, Leuckart and Montigozza.)

ACTION OF VARIOUS REAGENTS ON VIBRATILE CILIA.—*Continued.*

REAGENT EMPLOYED.	STATE OF REAGENT.	EFFECT ON MOVEMENT.	ANTIDOTE.	EMPLOYED BY
<i>Heat.</i>	40° C.	Stimulates.	May be revived.	Engelmann.
"	45° C.	Destroys in 1 or 2 minutes.	None.	"
<i>Increase in temperature in general.</i>		Increases electromotor and refractive power of cilia.		Cl. Bernard, Engelmann, (ref. 17).
<i>Decrease of temperature.</i>	—15° to +47° C.	" " " Human spermatozooids retain their power of motion.		" Montigozza, (ref. 85, 86).
" to	—6° C.	Does not permanently destroy motion in the cilia in Anodonta.		Roth, (ref. 38, 75).
" "	—17° C.	Does not permanently destroy motion in human spermatozoa.	Has been kept at 0° C. for four days without injury. Frozen semen recovers after thawing.	Montigozza, (ref. 85).
<i>Drying.*</i>		Produces rigidity.	Water, alkalis, heat, electrical irritation, dil. acids, ether.	Engelmann.
<i>Electricity.</i>	Constant and induced currents.	Stimulates similar to heat. Only ciliated epithelium of the frog has been used.		Kistiakowsky, (ref. 72). Stuart, (ref. 76).
"	Sudden changes in strength of positive or negative current.	Accelerates.		Engelmann, (ref. 17).
"	Induction shocks.	Produces a bent or cramped position similar to its effect on muscle.		"
<i>Illumination</i>		Changes in the degree of illumination have given no results.		"

* *Drying.* Semen dried in a solution of salt or in different substances, can be, in certain cases, again rendered active by dilution with the same fluid or with water. Külliker, (ref. 83).

ACTION OF VARIOUS REAGENTS ON VIBRATILE CILIA.—*Continued.*

REAGENT EMPLOYED.	STATE OF REAGENT.	EFFECT ON MOVEMENT.	ANTIDOTE.	EMPLOYED BY
<i>Detachment from cell body.</i>		Destroys. Motion however remains, if a small portion of the cell remains attached.		Engelmann. (ref. 17).
<i>Aniline</i> (red).	Sol.	Kills in 10 minutes. Cells refuse to take color while alive.		Leutmeyer, (ref. 59.)
<i>Woodward's Solution.</i>		Motion continues 10 hours with cilia becoming stained.		"

however, that the same phenomena are of frequent occurrence as well in the vegetable kingdom. Besides similarity of structure, the functions of the cilia are much the same in both kingdoms. They are, as a rule, slender, conical hairs, homogeneous throughout, smooth, colorless, uniaxial and doubly refractive, the optical axis always coinciding with the direction of greatest length. They possess a tolerable firmness, pliability and elasticity. They cannot be considered as protuberances of the cell wall, but pass through it, having their origin in the outer layer of the contained protoplasm—the ectoplasm. As in the animal kingdom, the number of cilia attached to a single cell, varies from a large number, forming a tuft or crest, to a single, usually very long, hair. Movements of cilia situated upon the same cell are isochronous. Cilia are found attached to fixed cells, (*Gonium*, *Volvox*, *Stephanosphaera*, *Pandorina*, and the Heterocysts of *Nostocaceæ*), or to freely motile cells, causing by their mechanical action the locomotion of the whole family or of the single cell, as the case may be. Corresponding to the animal spermatozooids, which are only peculiar modifications of epithelial cells, are the vegetable antherozoids. The origin of the force employed in ciliary motion, is, as we have noticed in a previous

chapter, undoubtedly the same for both animal and vegetable cells.

THE MOVEMENTS OF VEGETABLE PROTOPLASM.—(A.) Those movements which occur within the cell-wall, as circulation and rotation. (B.) The movements of free, naked, protoplasmic bodies, viz: amoeboid and ciliary movements.

It is to the latter group that we have our attention directed, and especially to that section of it, in which the movements produce no change in the external form of the cell, that is, to ciliary movement brought about by the rapid lashings of minute whip-like appendages (zoöspores, swarm-spores, &c.,) or by the undulations of filiform, primordial cells, each of which, in so far as its movements are concerned, is no more than an isolated cilium, (antherozoids and spermatozooids). While in a number of cases we may observe ciliary motion accompanying the plant throughout its adult existence, we find it chiefly employed as a temporary means, for the diffusion of particles engaged in the reproduction of species. Ciliary motion in plants is confined to the cryptogams, and it is only in the very lowest of these, that it occurs in the adult plant. It accompanies both asexual and sexual reproduction, which we will take up separately,—examining its manifestations in each.

CILIARY MOTION AS ACCOMPANYING ASEQUAL REPRODUCTION IN CRYPTOGAMS.—The motile cells concerned in asexual reproduction in plants have been named swarm-spores or zoöspores. These result from the contraction of the protoplasmic contents of certain cells, and its reconstruction into primordial cells, which escape from the mother cell either by openings, or by the dissolution of its walls. When liberated under suitable conditions the naked swarm-spores move with a rotary and progressive movement, the rapidity of which has been shown by Hofmeister* to be considerable. For example:

	<i>Mm. per second.</i>
<i>Fuligo varians</i> ,	.7 to .9
<i>Lycogola epidendrum</i> ,	.33
<i>Ædogonium vesicatum</i> ,	.15 .20
<i>Vaucheria sp.</i> ,	.10 .14

In some cases rotation has been noticed before the swarm-spores have left the mother-cells, a phenomenon corresponding exactly to the movement of the embryo within the ovum, (mollusca, &c.,) brought about by vibration of cilia, which are perfectly distinct. The duration of activity among swarm-spores is variable, ranging from one half, to one and a half minutes only in *Vaucheria*, up to a day or two in the myxomycetes.

The advancing movement, as well as the rotation about the longer axis, is occasioned by the rapid vibratory motion of extremely small, whip-like extensions of the hyaline portions of the protoplasm. These delicate threads are often very numerous, as in *Vaucheria*, where the primordial cell on escaping from zoösporangium is found to be covered everywhere by delicate, densely crowded, short cilia. In other cases (ædogoniæ) they form a crown or crest encircling the hyaline anterior extremity of the zoöspore, while more commonly there are but two cilia, usually very long, which are attached at the same point on the margin of the zoöspore.

In the myxomycetes and monoblepharidæ, however, we find but one long cilium, while in *Saprolegnia* proper there may be, either one before and one behind of unequal lengths, or two of equal length in front. It should be borne in mind that all swarm-spores are not ciliated, for, in the myxomycetes and *Peronospora* we see them endowed with amoeboid movement, and in the Hydrodictyæ the larger swarm-spores never leave the cell in which they have been produced. The zoöspores produced by a single mother-cell vary from five (*Cystopus*) to one hundred thousand, (small swarm-spores of hydrodictyæ) — the possession of vibratile cilia renders their dissemination a comparatively easy matter, water alone being needed, which, in the case of non-aquatic cryptogams, is furnished by rain.

On watching the swarm-spores swim about for a time, two individuals will be seen approaching each other; they will meet, coalesce, lose their cilia, and proceed in the regular course of asexual reproduction, which may easily be observed by sowing the pseudospores of *Cystopus* in water on a glass slip. Of special interest in the study of vibratile cilia, are the zoöspores produced by sowing the conidia of *Peronospora infestans*, the mould which produces the potato murrain. Germination is favored by darkness, and will commence in from one and one half to three hours, the ciliary movement continuing from fifteen to thirty minutes.

CILIARY MOTION AS ACCOMPANYING SEXUAL REPRODUCTION IN CRYPTO-GAMS.—In the sexual reproduction of plants only the male cells are endowed with motion, being known as male- or sperm-cells, antherozoids or spermatozoids. They are strictly homologous with the sperm-cells of animals, and resemble them closely. These male, motile fertilizing bodies consist of naked protoplasm, and are considered to be primordial cells.

* "Lehre von der Pflanzenzelle," p. 30. (Vide ref. 103.)

The part they play in the life-history of the plant, though transient (their movements not lasting longer than five minutes in the antherozoids of *Isoetes*, and but from one half to three quarters of an hour in *Selaginella*), is of the greatest importance. After their short but active life they disappear by being absorbed into the female or germ cell. Thus Pringsheim has observed the entrance of the spermatozoids into the protoplasm of the oosphere in *Edogonium* and *Vaucheria*, as Strasburger has also in regard to Ferns, while Hofmeister observed that they entered the archegonium of Muscinæ.

The spermatozoid or antherozoids are usually many hundreds or even thousands of times smaller than the oospheres which they fertilize. At times they become attached to the oosphere in such numbers that their combined movements are sufficiently energetic to impart to the large oosphere a rotatory motion, lasting for half an hour or more (Fucaceæ).

The great variety of the male cells becomes especially conspicuous if we compare the roundish swarmspore-like spermatozoids of *Edogonium* and *Coleochaete* with the bacillary spermatozoids of *Saprolegnia* (*Achyla dioica*) and with the spiral filiform antherozoids of the Characeæ, Muscinæ and Vascular Cryptogams the coils of which vary in number from two to three (*Nitella*) to twelve or thirteen (*Marselia*). In every case is the form adapted to produce the right kind of motion, in order to convey the fertilizing substance to the female cell, in a manner harmonious with its structure. With the performance of its function as a fertilizing element, the presence of cilia has only to do in so far as it is the means of bringing about the contact of the male with the female cell; then it is that its chemico-vital properties come into play, these properties being of course characteristic of the male element.

Algæ are distinguished from the rest of Cryptogams by their sperma-

tozoids never being in the form of slender spiral filaments, but always short and rounded, at least, at their posterior ends. In most algæ they resemble swarm-spores, but are usually much smaller (one half as large in *Saprolegnia*) and are provided with a red corpuscle. The mode of formation of antherozoids in the mother-cell is somewhat as follows: The contents of the cell appear to be perfectly homogenous, no nucleus is apparent, and the antherozoid originates from a shining granular mass of protoplasm which encloses a vacuole. In some cases (e. g. *Isoetes*) the cilia at one end are formed first, and the spirally formed body becomes differentiated afterwards by a sort of splitting of the protoplasm from before backwards. In *Isoetes* the antherozoid is spirally coiled about the central vacuole, which, being surrounded by a fine membrane, not unfrequently remains attached to its posterior extremity after it has escaped, and is carried along with it. In other cases (Filices, Rhizocarpeæ) it is only the parietal portion of the contents of the mother-cell which goes to form the filament and cilia, while the central part, as a vesicle filled with colorless granules, or with starch grains and sap, remains for sometime attached to the posterior or thickened end of the filament. This vesicle is not a part of the antherozoid since it subsequently falls off, and remains at rest, while the filament alone continues in motion.

The number of spermatozoids produced by one mother-cell varies from one (Filices, Rhizocarpeæ, Lycopodiaceæ) to one hundred, or one hundred and fifty (Equisetaceæ). From the commencement of germination up to the complete maturity of the antherozoids there is (in *Isoetes*, e. g.) an interval of about three weeks. Like zoöspores, they sometimes begin to rotate even while yet within the mother-cell (*Characæ*, e. g.). As a rule, the filaments are perfectly clear; at times, however, a few glistening

granules are apparent in their posterior thickened extremities (Characeæ, e. g.).

The antherozoids of the Equisetaceæ are larger than those of any other class of Cryptogams. Vegetable spermatozoids show, in a manner similar to those belonging to the animal kingdom, a gradual transition from the freely motile filiform cells—the archetypes of ciliary motion—to those which it would be difficult to distinguish from isolated epithelial cells of animals. From their mode of development (e. g. *Isoetes*), we have seen that the cilia are the essential portions, and that the presence of a cell body is a secondary affair, being a subsequent process of differentiation. From this we would infer that there must exist in the cilium the power of originating its own motion; it is self-innervating. The mechanism of its movements is identical in principle with that of muscular movement, while the proceedings which stimulate these movements are identical in principle with nerve incitation.

(To be continued.)

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

A NEW BINOCULAR.—Mr. Edward Bausch has devised a modified form of the Wenham binocular, and adapted it to the Bausch & Lomb stands, one of which we have recently examined. Instead of mounting the prism in a metal frame which can be moved in and out, as in the ordinary form of binocular, the prism is ce-

mented to a glass disk which is fixed in a special nose-piece. The nose-piece can be readily attached to the microscope by a spring-catch.

In this way the prism is always secured in exactly the right place, and when a plain nose-piece is substituted, as when high-power objectives are used, there is nothing in the tube to reduce the angular aperture of the lens. The arrangement is less convenient than the ordinary plan, but if the advantages claimed for it are found not to be of sufficient practical importance to lead to its final adoption, there is no reason why the prism should not be mounted in the old way. We do not yet appreciate the advantages of the separate nose-pieces, and we understand that the makers desire to have the verdict of microscopists concerning this matter, before they adopt the plan.

The prism is a very large one, and as the face which receives the rays is fully exposed it will transmit a larger angle of aperture than the Wenham prism, which is much smaller. It is well-known that the mounting of the Wenham prism cuts down the angular aperture of some objectives. A large prism, however, gives a correspondingly large pencil of rays, and in the instrument we examined there was a glare of light in the left ocular which led some who used it to think there was a defect in the fitting of the prism. On covering the right-hand half of the eye-lens of the left ocular, the glare was entirely stopped out, and the binocular effect was perfect.

Mr. Bausch has promised us a description of the apparatus, which we will soon publish, as we prefer to leave a detailed statement of the special advantages of his binocular in his own hands.

HINTS TO MANUFACTURERS.—Judging from various indications, the question will soon force itself upon the manufacturers of microscope stands

whether they will design and make stands such as the laboratory worker finds most useful, or, by continuing in the beaten way, let the German stands come into our laboratories. We are led to say this because the subject has recently been forced upon our attention. It is quite useless to say that American microscopes are better than German or French ones. It is not a question of what we consider best. The practical question is, what stand is, or will be, most in demand by laboratory workers?

In Harvard Medical College — a medical college which probably stands deservedly higher than any other medical school in the country — Hartnack microscopes are almost universally employed. In the seaside laboratory at Annisquam, Hartnack stands are preferred. It is even asserted, upon good authority, that students who go to Germany with fine American stands are almost sure to discard them for German stands.

Now, it becomes us to inquire the reason for these facts. Mr. J. S. Kingsley, in his book recently published, the *Naturalist's Assistant*, says that the simplest stand is the best, and that American objectives cost too much. These statements, and some others made by the same author, will rouse the indignation of our makers of microscopes; but it is a question whether it would not be better to accept the conditions and make stands that are adapted to the wants of students, rather than to attempt to reform or educate the Harvard professors up to an appreciation of the excellency of American stands and costly objectives.

Let us look at this matter fairly. It is useless to say that such men as we find at Harvard do not know what is best for their own use. They find that a small, low stand is best. Why? Because the kind of work they do requires a stand that can be used in an upright position with ease and comfort. Substage accessories are, for their work, generally useless,

hence no additional space is required beneath the stage. Say what we will about the discomfort of a vertical microscope, there is a great deal of laboratory work in which the instrument must be used in that position.

Within a few years some of our makers have introduced stands which can be highly recommended for laboratory work, and we have seen many of them in colleges throughout the country.

As regards objectives, it is confidently asserted that good Hartnack lenses can be bought for less than correspondingly good American lenses. For ourselves we do not care to venture an opinion upon this subject. We give the opinions of others for what they are worth.

It seems not unlikely that they are due to the wide-spread impression that cheap American objectives are of very inferior quality, and that our makers can only produce good lenses at a high price. We are aware this is not true, but it is not "we" that buy the objectives for the laboratories. Then too, it is considered that if an American objective is a good one it must have a collar-adjustment, which increases its cost. What is wanted for laboratory work is good objectives without collar-adjustment to compete with those of Hartnack, Zeiss, and others.

That we have them there is no doubt, but it remains to convince purchasers of the fact that they can be sold equally cheap. We are not advocating the use of inferior objectives, but of good objectives with lenses in fixed mountings.

ERRATA. — We notice two typographical mistakes in the report of the President's address before the New York Microscopical Society, Page 6 col. 1, line 6 from bottom, *Circularæ* should be *circularæ*. Page 66, col. 2, line 8 from bottom, "organisms in which" should be "organisms on which."

NOTES.

— Mr. John Michels proposes to establish a new paper in this city, to be known as *Health*, "a Journal of Household Necessities and Comforts." For the present it will be a monthly, but it is proposed to issue it weekly before long.

— It is well known that some fungi are phosphorescent, and the light is generally supposed to come from the fungus itself, but some recent observations have shown that, at least in certain cases, there are bacteria allied to *B. Catenula*, Ehr., which are luminous, and are in part the source of the light.

— The Portfolio of Drawings issued by Thomas Bolton, of Birmingham, England, is a very useful publication for microscopists who collect pond-life. The number for March, 1883, has recently come to hand. It contains illustrations of sixteen species of infusoria, with short descriptions of each. The drawings are not equal to engravings on wood or stone, but they are sufficiently good for their purpose and cost.

— If the living stem of a plant is cut obliquely and placed in water under the microscope, so that the thin portion of the cut end can be examined, by adding to the water a little freshly precipitated calcium oxalate, or other finely divided substance, it may be seen that currents flow toward the cut surface, and the particles suspended in the water show the direction and rate of flow of the currents. If the leaves are removed the current ceases. This experiment shows the current of water in growing wood.

CORRESPONDENCE.

A CANADIAN SOCIETY.

TO THE EDITOR.—For the purpose of encouraging investigation into our almost unknown northern fauna, especially that belonging to the lower forms of life, a society was organized here last autumn, under the name of the "Ottawa Microscopical Society," with J. F. Whiteaves, F. G. S., as President, and J. B. Tyrrell, F. G. S., as Secretary.

During the winter, monthly meetings were held, each being devoted to a single topic which was introduced by a paper

from one of the members, and illustrated by slides and preparations brought in by the leader and all others who took an active interest in the subject. The general discussions which invariably arose after the reading of the papers also added very much to the pleasure of the evenings.

The subjects taken up during the winter were as follows:—Foraminifera, introduced by Mr. J. F. Whiteaves; Rock Sections, by Mr. F. D. Adams; Parasitic Insects, by Mr. J. B. Tyrrell; Fresh-water Diatoms, by Dr. A. F. Kemp; Human Cellular Tissue, by Dr. Small; and Wings of Lepidoptera, by Mr. W. H. Harrington.

During the months of spring and summer the members will devote themselves to collecting specimens and studying living forms as they occur in the field, that they may again begin their meetings with renewed interest and vigor.

J. B. TYRRELL, *Secretary*.

OTTAWA.

MICROSCOPICAL SOCIETIES.

At a meeting of the NEW YORK Society, on the evening of March 16th, Mr. N. L. Britton gave an interesting account of the structure and functions of pollen-grains. He briefly alluded to the two methods of propagation in the vegetable kingdom, viz.,—by conjugation and without conjugation. The protophytes have asexual methods. Referring to the common marine plant *ulva*, he said there were produced two kinds of zoöspores, one kind large,—macrozoöspores—which when set free fall to the bottom and grow directly into new fronds, the other small—microzoöspores—two or more of which may conjugate and form a zygospore. Rising higher in the scale of life the plants become dioecious. In the ferns there is produced a prothallium in which the reproductive process takes place. Among all the higher plants propagation is sexual.

The pollen-grains of the angiosperms are always covered by two membranes, the outer being developed from the inner. The protoplasmic contents are granular, containing starch-grains, globules of oil, and small particles $\frac{1}{4000}$ to $\frac{1}{8000}$ of an inch in diameter, called fovillæ, which are the fertilizing elements of the cell. By placing the pollen-grains of the Calla in water, under the microscope, they can be seen to swell and burst, extruding the fovillæ.

By the aid of the black-board some typical forms of pollen-grains were described. There is great variety in form, and the surface-markings not only add to their beauty, but enable them to become readily attached to insects which thus aid in cross-fertilization by carrying the grains from one plant to another.

The pollen-grains, when they become attached to the pistil, extend their envelope in the form of a tube — the pollen-tube — which makes its way through the tissues of the style and stigma, down to the ovary, where it discharges its fovilla, and fertilizes the germ-cell of the future seed.

The paper was very interesting throughout. At its close there was some discussion as to the fact of the pollen-tubes extending down as far as the ovary. Mr. Britton thought there could be no question that they did so. In one case he had clearly observed it.

A new form of microscope-table was shown by Mr. Schrenk. The particular feature of the table was a revolving centre upon which the microscope is intended to be placed.

Ten different kinds of pollen-grains were shown by members.

At a meeting of the NEW YORK Microscopical Society, April 6th, a lecture was delivered on the subject of "Deep-sea Sounding and Dredging." This lecture was the first of two lectures to be delivered on this subject, and was confined to a description of the apparatus and methods employed in deep-sea work. It was illustrated by lantern transparencies, using an oxyhydrogen lantern.

NOTICES OF BOOKS.

The International Scientists' Directory. Containing the names, addresses, special departments of study, etc., of amateur and professional naturalists, chemists, physicists, astronomers, etc., etc., in America, Europe, Asia, Africa, and Oceania. Compiled by Samuel E. Cassino. Boston, U. S. A.: S. E. Cassino and Company. 1883. (Pp. 458).

This valuable publication is out early in the year, and is much more complete than any of its predecessors. It contains 450 closely-printed pages, and for accuracy it seems far more creditable than any other directory we have seen.

Tenth Annual Report of the Secretary of the State Board of Health of the State of Michigan, for the fiscal year ending September 30, 1882. Lansing: W. S. George & Co., State Printers and Binders. 1883. (Pp. 37 and 592).

This Report contains some valuable essays on special subjects, relative to sanitary matters, such as ventilation, plumbing, drainage, etc.

Les Insectes Fossiles, specialment d'après les travaux de Sir Samuel Scudder. Par Charles Maurice, Licencié ès-Sciences naturelles. Lille: Imprimerie six-horemans 244, Rue Notre-Dame. 1882. (Pamphlet, pp. 32).

We are indebted to the author for this interesting brochure, the nature of which is sufficiently explained by the title. It is an extract from the *Annales* of the Geological Society of the North.

Exchanges.

FOR EXCHANGE.—Well-mounted double-stained vegetable preparations, also, a few first-class injected preparations for other well-mounted slides. N. A. Richards, St. Louis, Mich.

WELL-MOUNTED slides of Polycystina, transparent and opaque, for any well-mounted slide. P. C. Cole, M.D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 103 Virginia St., Richmond, Va.

DIATOMACEOUS MATERIAL and Histological slides for other well-mounted and named slides of Foraminifera, Animal Parasites, Pathological subjects, etc. R. Cauch, M.D., Carpenteria, Cal.

SECTIONS: Kitten's Jaw, teeth *in situ*, in exchange for first-class slides. Jay L. Smith, 86 Beekman St., New York City.

FOSSIL DIATOMS from Carson, Nev., and Fosa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

FOR SLIDES of Diatoms from the Wabash & Erie Canal at Ft. Wayne, send any well-mounted slide to H. C. Tresselt, Fort Wayne, Ind.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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BOSTON, JUNE, 1883.

No. 6.

The Podura Scale.

BY THE EDITOR.

An article on this subject, published in the December number of this JOURNAL, called attention to the podura scale as a valuable test-object, although the structure of the scale is still to many minds, a matter of uncertainty. There are still a few persons who cannot grasp the idea which has been set forth time and time again in these columns, that the appearance of an object in the microscope is not necessarily a truthful representation of its structure. But those who, from inexperience, or want of accurate information concerning the present theory of microscopical vision, do not understand how this can be, should not be too hasty about questioning facts so universally admitted by the best informed and experienced microscopists.

In the February number of this JOURNAL, on page 30, it was briefly explained that objectives cannot be properly corrected by the use of unknown objects—that is, by objects of which the correct appearance is not known. If the podura scale is to be

used as a test-object, it is important that its correct appearance should be known. In the first article two different appearances of the spines were described. Which is the correct appearance is still uncertain, but Mr. Stodder, in a recent article,* even

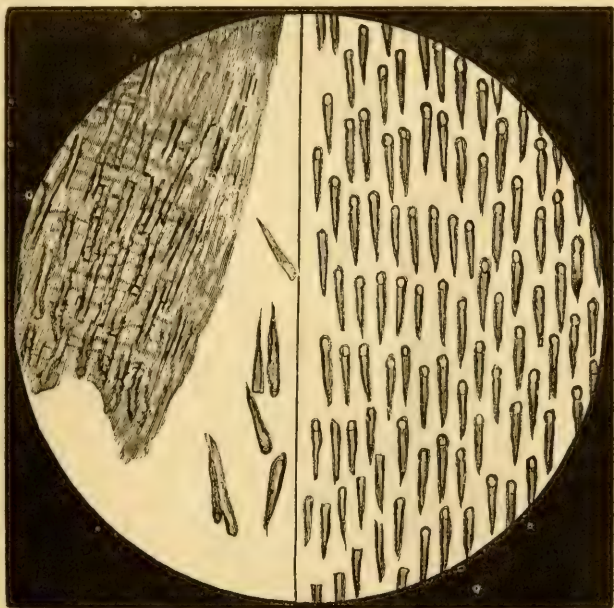


FIG. 18.

questions the existence of true spines on the scale.

A long time ago our attention was drawn to some photographs by Dr. J. W. S. Arnold, of this city, which have been on exhibition in Mr. Woolman's store. The photographs were made

* Vol. IV. p. 4.

by sunlight with a $\frac{3}{8}$ inch objective by William Wales, and the magnification was, in two instances, 2470 and 2740 diameters respectively.

In the accompanying engraving (fig. 18) we have very accurately reproduced portions of the two photographs.

The drawing was made on the block by Mr. E. Q. Morton, and is a very faithful copy of the photographs. On the left-hand half is represented the appearance of the test-podura-scale. Some of the spines show the appearance of a distinct head to the internal line of light, such as was described in Vol. III., page 225. We regard this as a very correct representation of the appearance of the test-podura scale, as shown by good objectives. We believe that Mr. Wales considers it to be the proper appearance of the spines.

On the right-hand half of the figure are shown some detached spines, not of the podura, but of the insect *Degeria domestica* so closely allied to it, that it may be fairly assumed the structure of its scales is the same. The remainder of the engraving shows a portion of the scale from which the detached spines came, quite out of focus, however, as the photograph was made to show the detached spines. The later were separated by accident. The accident was a fortunate one, as it enables us to see the separate spines, thus proving that they have an existence, and disproving some views that have been advanced in the past concerning the structure of the scale.

Some readers will doubtless remember that the spines of podura have been separated from the scales by an electric spark, so that they could be seen and studied in a similar manner.

Binocular Vision.

[At a meeting of the Royal Microscopical Society of London, held some time ago, Mr. F. Kitton read an article on "Binocular Vision in the Study of Diatomaceæ." As the advantages of binocular vision are still

doubted by many observers, the opinions of several gentlemen whose names are well known to all microscopists, may be read with interest. — Ed.]

Mr. Beck said, that with reference to the opening remarks of the author on the value of binocular over monocular vision, he could fully bear out all that had been said. A valuable means of convincing any one who was sceptical on the subject was to be found in a slide of *Aulacodiscus*; and he remembered that when his brother Richard showed this diatom to Mr. Tuffen West for the first time under the binocular, that distinguished draughtsman looked at it for some time in silence, and then jumping up, exclaimed: 'All the drawings of diatomaceæ which I have done will have to be done over again!'

Dr. Wallich said that he could fully confirm the statement that nothing showed diatoms so well as the binocular. Indeed, from a study of these objects, extending over many years, he could say that it was utterly impossible to see them in any other way. In one of the drawings of *Hydrosira* he observed that Mr. Kitton had not noted the unsymmetrical formation, consisting of a little dot, which was generally surrounded by a slight ridge on one side only. It occurred in *Hydrosira* and many of the discoidal forms, and though often seen, he had never yet been able to detect what this peculiar structure was. It would be of advantage if some one would set to work to determine it. It seemed to him to have something to do with the communication between adjacent frustules.

Mr. Crisp said that Mr. Kitton had proved conclusively the superiority of the binocular, in that he had shown the true form of diatoms, which had previously been misinterpreted by most experienced observers after observation with the monocular.

Mr. Stewart said that there were still some persons who appeared to think that the binocular was a mere toy. It was, however, of really great

importance, especially when working on an exceedingly transparent object, where the inner membranes could be distinctly separated from those above them; or, in tracing out fine nerve fibres, which, passing over or under each other, could be resolved in a way which was entirely impossible by any other means.

Mr. Beck believed they were only as yet in the infancy of the binocular microscope; and he looked forward to the time when much more attention would be paid to its construction, and particularly to the question of ascertaining the best point at which the prism should be placed to get the full field, without adventitious aid in the way of illuminators, by which improved results would, no doubt, be obtained. He believed that the binocular was the microscope which would be used in the future.

Dr. Gibbes said he could corroborate all that had been said on the subject of the binocular, and especially its value when used with a $\frac{1}{2}$ -inch in examining those very minute parasites to which his attention had been given, as it enabled him at once to see whether they were outside or inside the tissue.

The "Facility" Nose-piece.

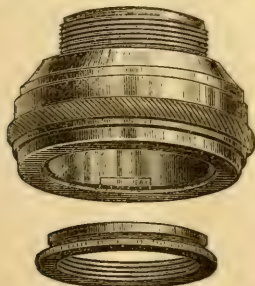


FIG. 19.

We have already alluded to this convenient and ingenious accessory in these columns, and now we present our readers with an illustration of it, (fig. 19) which will give a good idea of its merits. We have used one of these

nose-pieces considerably, having it attached to the stand all the time, and have found it a very convenient accessory. We prefer it to the double nose-piece heretofore used on the same stand.

A small grooved ring is provided for each objective, which is screwed down against the shoulder. The ring is seized by three jaws in the nose-piece which act upon the principle of a self-centering chuck. By a very short turn of the milled head the objective is secured or released. The ingenious arrangement of the jaws need not be described in detail, but in practice they work beautifully.

The rings on the objective are so small that they do not interfere with putting the latter into its box.

Zool. Anzeiger VI., N. 129 (8th Jan., 1883.)

1. Balbiani and the Conjugation of the Infusoria.

BY O. BÜTSCHLI OF HEIDELBERG.

Although I am in no way a friend of controversy in the province of our science, knowing that it has no value at all for its progress, I feel compelled to lay aside for once this disinclination, and to criticise a colleague, with whom I least like to fall out in this manner. I desire to be brief and therefore begin at once with the special subject of discussion.

In the *Journal de Micrographie*, little circulated in Germany, edited by J. Pelletan, there have been published since February, 1881, the lectures delivered by Prof. Balbiani at the College de France, on "Protozoa." From the tone of these publications, it becomes apparent that they proceed directly from the pen of Balbiani, and were not written down by a hearer of his lectures.

Until now these publications occupied themselves with the description of the Infusoria, and quite recently there began also the discussion of Sporozoa and Flagellata. What interests us here is the description

of the Infusoria, and especially the extensive chapter on their conjugation.

No one, indeed, was more fit to express himself on this interesting subject, especially as regards my investigation of it, than Balbiani. Indeed, he was the pioneer in the investigation of this unexplored field—an investigation, whose depth, scope and accuracy is amazing, if we reflect that they have been conducted under and retarded by an erroneous conception of the nature of the processes investigated.

Under these circumstances everybody can conceive the great satisfaction, which I felt, when on looking over Balbiani's publications, I noticed, that his recently repeated researches on the conjugation of Infusoria led him to corroborate everything essential and to give up entirely his former views on the course of this process. This corroboration of my observations coming as they did from most competent authority, were very welcome to me, in spite of Balbiani's slight objections, for I had felt that in the course of years the result of my investigations had been received with some distrust.

This I regret, was owing partly to those, who attempted to see what I could see. Now, having experienced how many pupils of mine had to work hard to fully observe the process, I conceive that it requires considerable exercise, and that one has to meet with numerous unsuccessful attempts before he reaches the full understanding of the matter.

Having been, as stated above, favorably surprised to learn that Balbiani now agrees with me perfectly regarding the process of conjugation of, and in the conjugated infusorias, how much greater was my surprise on reading the following passage with which Balbiani concludes his description of the conjugation: "Je me trouve ainsi ramené aux idées que j'ai émises, il y a plus de vingt ans, sur la signification de la conjugaison; il n'y a de changé que quelques détails

du processus, mais le fond de l'interprétation est resté le même qu'il y a vingt ans. Bütschli a donc, par ses travaux, rendu services à cette idée, et l'on peut se demander même, si c'est observateur éminent, en refusant de reconnaître la génération sexuelle des infusoires, n'est pas tombé dans une erreur plus grande que je l'avais fait jadis. En somme, il laisse le phénomène de la conjugaison plus obscur qu'il n'était avant ses recherches, et si j'ai réussi à jeter quelque jour sur ses faits, j'aurai complètement atteint le but que je m'étais proposé."

One who knows Balbiani's and my former investigations on the conjugation of Infusorias, must be astounded at the courage which our French colleague possesses, to send forth such a statement, which, at best, some would call a "pyramidal" one. He may possibly, with such statements, deceive his pupils in the college of France. In Germany, however, and in the rest of the zoölogical world (except perhaps in a part of the French one) I confidently hope he will not succeed.

Let us look closer however into the assertions contained in that passage. Let us see what views Balbiani held twenty years ago on the mode of conjugation, and the views that I expressed in 1876, of which Balbiani in 1882 confirmed, as stated, all the essentially important points.

According to his results in 1861, the essential part of the conjugation consists in the following:

1. Infusoria are animals, which in regard to their propagation are like the Metazoa. They contain an ovary (the so-called nucleus) and one or more testicles (nucleoli).

2. The mode of propagation is also similar to the copulation (coition), except this peculiarity, that the maturity of the sexual organs and their products begin during the act of conjugation.

3. During or after the act of conjugation one or more eggs are developed out of the ovary (nucleus), which eggs are sent forth after the

impregnation, and then their development goes on in a manner yet unknown.

4. The testicles develop themselves during conjugation, usually by increasing to seed capsules, and these become exchanged between the animals that have connection with each other, in order to impregnate the eggs, as the spermatozoa come out of the capsules and enter the eggs.

5. After the propagation, *i. e.*, after depositing the eggs, the animals produced by the conjugation gradually reconstruct their sexual organs again, and live an asexually productive life, *i. e.*, by division, yet a special mode regarding the reproduction by division of those animals produced by conjugation cannot be established.

To these five points which state the quintessence of Balbiani's conception and interpretation of conjugation, I desire to put in juxtaposition five propositions as results of my investigations in 1876, those points, which Balbiani, as above remarked, confirmed in all essentials.

1. Infusoria are *not* animals that can be classed with the metazoa, they contain *no* ovaries, no testicles, but are unicellular like the rest of the Protozoa, and have two kinds of cell-nuclei, a so-called secondary nucleus (main or nucleus proper, Balbiani's ovary), and one or more primary nuclei (so-called nucleoli, Balbiani's testicles).

2. The act of conjugation cannot be compared with the copulation of the Metazoa, but with the act of fertilization, between the ovum and the seminal vesicle of the same. We can therefore speak here of hermaphroditic plasticles in the sense of Hæckel, (compare p. 216 of my pamphlet, reprint.)

3. Infusoria do not form ova during or after their conjugation out of the nucleus, (secondary nucleus,) so-called; what Balbiani considered to be ova, are partly products of decomposition of the dying secondary nucleus, partly however metamorphic products of the primary nucleus or

nuclei which develop during their conjugation. The secondary nucleus, therefore, does not develop any ova, it rather becomes partially or wholly annihilated, either by dissolution or elimination of its diversely metamorphosed remnants, or by a sort of decrescence of the entire secondary nucleus.

4. There are not developed any seminal vesicles (Balbiani's "testicles,") out of the primary nuclei. On the contrary they pass through peculiar metamorphic processes which are connected with reproduction, in the course of which there grows out from a part of the primary nucleus one or more bodies of the quality of the secondary nucleus, which are destined to replace the lost secondary nucleus, or to combine with a remnant of the same to form a new secondary nucleus.

5. Out of the conjugation there come forth animals, which, though their secondary nucleus is undoubtedly newly formed, or increased by an additional part, can be designated in a certain sense as new beings. These animals rejuvenated by conjugation, distinguish themselves by very energetic growth, and rapid increase by division. After their increase has continued by division for a certain time, the sire of the animals decrease more and more, and finally there arises a new period of conjugation and rejuvenation.

Now I desire to recall to the reader Balbiani's words, which he applies to describe the question of conjugation, twenty years ago and to-day. "Il n'y a de changé que quelques détails ou processus, mais le fond de l'interprétation e resté le même, qu'il y a vingt ans," and then further the classical expression: "il (Bütschli) laisse le phénomène de la conjugaison des infusoires plus obscur qu'il n'était avant ses recherches."

I think the reader will be astonished at these remarks, just as I was, when I read them. Balbiani himself must be so, when he compares these words of his, with those which he wrote

a few pages before. We read as follows: (page 211), "mes observations sur la conjugaison des Vorticelliens (compt. rend. acad. d. sc. 1875), ont été effectuées sous l'empire des idées que je m'étais faites de ce phénomène où je voyais un processus de reproduction sexuelle, *car le grand mémoire de Bütschli, qui m'a ouvert les yeux sur sa signification réelle, n'a paru que l'année suivante.*"

I would ask how Balbiani could properly designate me as an investigator, if I succeeded so far as to leave the domain which he worked up less enlightened. In the above cited passage there remains nothing but the assertion, that I refused to recognize the "génération sexuelle" of the Infusoria, which Balbiani had discovered twenty years ago, and Balbiani is now more than ever convinced, that the Infusoria while in conjugation form a "génération sexuelle." The way he tries to explain it now is, that the Infusoria are hermaphroditic cells, with a female germ (the secondary nucleus), and one or more male or primary germs or nucleoli.

This view was propounded first by O. Hertwig*, as Balbiani incidentally mentions, and therefore no credit is due the latter: During the conjugation the capsules of the nucleoli are said to be partly exchanged between the two individuals, and therein consists the proper fertilization, *i. e.*, the entrance of a male germ into another infusoria individual.

Instructions in Dry-Plate Photography.

(Continued from page 88.)

After the negative is fixed and dried it should be examined to see that there are no defects, and if quite satisfactory it may then be varnished. It is advisable to purchase a varnish for

the purpose, rather than to undertake the trouble of making one. The varnish should be thin. It is applied by pouring a quantity upon the plate held in the hand, causing it to flow over every part and then pouring it off into the bottle again. The thin film dries in a few moments, when the negative is ready for use, unless some pin-holes and bad spots are observed which require to be removed by the artistic use of a pencil, in which case the novice had better take some instructions, in retouching negatives from a practical photographer before attempting to remove them.

When, owing either to insufficient exposure or to improper development, the negative is too thin to yield good prints it should be intensified before it is varnished. We give two methods of intensification, the first of which is, we believe, most frequently employed, but the second we have used with great satisfaction, and in some cases it seems to yield the most excellent results of any process we have tried.

If possible, avoid the necessity of intensifying. Make the exposures with judgment, and develop so as to obtain sufficient density without any after treatment. In spite of all care, however, it will sometimes be necessary to resort to intensification. But the beginner must learn that a negative that looks very thin will sometimes print well. A few experiments will show how dense the negative must be to yield good prints. The two methods of intensifying will now be described.

1. Mercury intensifier.—Three solutions are first prepared as follows:—

- a. Mercuric chloride
(corrosive sublimate), 60 grains.
Water, 4 ounces.
- b. Potassic iodide, 90 grains.
Water, 2 ounces.
- c. Sodid hyposulphite 120 grains.
Water, 2 ounces.

Add *b* to *a*, which will throw down a precipitate of mercuric iodide, and then add *c* which will redissolve the precipitate more or less completely. The solution will then be ready for

* Beiträge zur Kenntniss der Bildung und Theilung des thierischen Eies. Morphol. Jahrbuch, 1. Band, p. 347.

use, and it can be used repeatedly until it ceases to act.

To intensify a negative it is thoroughly washed, so as to remove every trace of hyposulphite. It is then immersed in the intensifying solution until it acquires sufficient strength, after which it is washed and dried.

If the solution acts too quickly the strength may be reduced by the addition of water. Some persons prefer to use a very much weaker solution than we have given above.

2. Silver intensifier.—There are two solutions requisite in this process:—

- a.* Pure ferrous sulphate, 5 grains.
Citric acid, 10 grains.
Water, 1 ounce.
- b.* Silver nitrate, 20 grains.
Water, 1 ounce.

After fixing, the negative should be thoroughly washed. When this method of intensification is to be followed we prefer to fix the picture in a solution of 30–40 grains of potassium cyanide in 5 ounces of water instead of in the hyposulphite solution. The negative should not be allowed to dry before it is intensified.

The operation is conducted as follows: The negative is placed in a clean developing pan and flowed with a sufficient quantity of solution *a* to cover it, having previously added one of two drops of solution *b* to each ounce of solution *a*. Keep the solution gently flowing over the plate. In a few moments the picture will begin to increase in density, and as it slowly grows darker and darker the operation can be stopped at any moment by washing in water. It is advisable to mix a fresh solution for each plate, for when the liquid becomes turbid it should be thrown away.

PRINTING.—The next operation to be described is printing. For this purpose a printing-frame is required, which can be obtained from dealers in photographic goods. Prints may be made either on “ferro-prussiate” paper, which gives figures in blue on a white ground, or on the silver paper in general use by photographers. The

blue prints are so easily and cheaply made that there is much to commend them. They do not compare in delicacy with silver prints, but they serve very well for many purposes. Silver prints are more troublesome to prepare, and for this reason we have heretofore advised beginners to send their negatives to practical photographers to have them printed. However, as many prefer to do all the work themselves, we will give full instructions for preparing the solutions and using them.

BLUE PRINTS.—The ferro-prussiate paper can be purchased in large sheets ready for use. It can be kept for some time without spoiling, but as it is a very easy matter to prepare the paper, we prefer to make our own. Select a good quality of book paper, not glazed but smooth and well-finished. Cut it in sheets of convenient size to be easily coated—about ten inches by twelve is a good size.

The solution for sensitising the paper is made as follows:

- a* Dissolve 35 grains of prussiate of potash in half an ounce of water.
- b.* Dissolve 51 grains of citrate of iron in half an ounce of water. Mix the two solutions and pour the mixture into a small dish or saucer.

Select a smooth board, spread a sheet of the paper upon it, and in a room lighted by a lamp or candle brush the surface of the paper with the solution by means of a small piece of sponge or cloth. Only enough of the solution should be applied to coat the paper evenly—not enough to run in streaks when the paper is hung up to dry. When coated, the paper is suspended by one corner, and left to dry in the dark. The sheets will keep for some time, if placed in a dry place protected from light.

Place the negative in a printing-frame, then place a piece of the sensitized paper in contact with the varnished face of the negative, close the frame and expose the picture to the light. Allow the printing to con-

tinue until the paper becomes of a greyish color where the light acts most strongly upon it. Then remove it from the printing-frame and wash it thoroughly in water. The image then comes out of a deep blue color, and has only to be dried.

SILVER PRINTS.—For silver prints it is advisable to purchase sensitized paper. It can be obtained from dealers in photographic goods, who do not like to sell less than a dozen large sheets however, or from the local photographers who can usually spare a sheet or more from their own stock. There is this fact to be borne in mind, however, that the paper sold by the dealers is prepared to keep for a long time without discoloration, while the paper prepared by photographers is intended for immediate use.

For silver prints the sensitive paper is placed in the printing-frame and exposed to light as already described, but a much weaker light and a shorter time is required for printing than when ferro-prussiate paper is used. Unless the negative is very dense, direct sunlight should never be used in printing. Expose to the diffused light of the sky, or cover the face of the printing-frame with white tissue-paper and let the sun shine upon that. In this way a strong but evenly diffused light is obtained which gives excellent results. With very thin negatives print in a weak light. Print the pictures a little stronger than it is desired to have them appear when finished, for they will lose some strength during subsequent operations. Choose a bright day for printing, and make a number of prints, for it takes but little more time to tone and fix a dozen than a single one.

After printing, trim the prints, that is, cut them to the proper size for mounting. Then place them in a dark box or drawer to remain until late in the afternoon when the light grows weak so that the operations of toning can be undertaken. Toning may, if necessary, be done after a day

or two, but if possible it should be done on the same day as the printing.

TONING.—The prints are first thrown into a tub or basin of water, where they should remain an hour or so, changing the water occasionally. They are then taken singly and placed, face down, in the toning bath, which, in well-appointed galleries is held in a large shallow porcelain dish, but we have used a large platter for the purpose. The toning bath is made as follows: Make a stock-solution of chloride of gold containing 2 grains to an ounce of water. Then mix

Chloride of gold solution, $\frac{1}{2}$ ounce.

Sodic acetate, 50 grains.

Water, 20 ounces.

This solution should stand several hours before it is used. If it does not tone readily add a little more of the gold solution. After use the solution may be preserved, and again employed adding a little gold if necessary.

The toning goes on more or less rapidly, and a gradual change in the color, or tone, of the picture will be observed. This change must be stopped at the right point, and this point can only be learned by experience. Hold the picture up to the light and look through it. When the toning is done the whites are clear. It is usual to watch the progress of the toning by picking up the prints singly and throwing them back in the solution face upward. When all are turned reverse them again in the same way. By repeating this procedure the prints can be picked out as they are toned and thrown into the fixing solution. When all are toned place them for at least fifteen minutes in a solution of two ounces of sodic hyposulphite in eight ounces of water. After this wash them thoroughly in water. If the washing can be continued all night in running water it is recommended, but if not, the prints should be allowed to soak all night in a large volume of clean water.

They will then be ready to be mounted on cards, or they may be

dried for mounting at some future time.

In our next article we propose to describe the method of making transparencies for the lantern for the illustration of lectures.

To be continued.

Histological Work.

By J. F. HAZELWOOD.

During the past two years I have given *especial* attention to histology. In my work I have followed minutely many of the methods suggested by Beale, and with excellent results. For the carmine stain, however, I have used the preparation given by Dr. Seiler. Not satisfied with the differentiation of the single stain, after many experiments I secured a blue stain composed of rosaniline, aniline oil, and sulphuric acid. In this way, I get the finest demonstration of tissues I have ever seen; for while the carmine gives the nuclei, the blue will give the outlines of the cells, fibrillæ of muscles and nerves, connective tissue, fibres, etc. For instance, I had several tongues of frogs, which had been stained with carmine and mounted in glycerine and acetic acid, after Beale, and left for nearly two years sealed up in glycerine. I took them out of their cells and put them through the blue stain, and then mounted each tongue in a series of slides, with glycerine as the medium, and got a *magnificent* demonstration of simple and compound papillæ, with the branched muscle-fibres and delicate nerves *in situ*, also nerve-trunks and ganglion-cells; such a demonstration, indeed, as delights the heart of the histologist.

The skin of the frog has by the use of this same double stain, furnished another means of studying the beautiful arrangement of the nerves. Even the most delicate nerve-fibres are thus brought out with great distinctness, so that one can readily find them with a low power, and at once

turn upon them his highest objectives. In vertical sections of nerve-trunks, by this treatment, the outline of the individual sheaths is distinctly given, with the axis-cylinder in the centre—a most beautiful sight. So great is the change wrought by this blue stain, that I have dismounted many of my old slides, and put them through this process, and then remounted in balsam or glycerine at pleasure.

This stain gives equally surprising results in differentiating the tissues of insects. Nerves and tracheæ and cell-walls are finely colored. The most beautiful liver-cells I ever saw, were thus double-stained. The fine net-work of muscles and nerves on the stomach and intestines and on the glands, is thus brought out with stereoscopic effect. I have, in this way, on the beautiful muscles of the lampyridæ, distinctly seen the accessory discs of Engelmann.

One of the most gratifying results thus obtained, was the demonstration of the nerves and ganglia in the thin membrane of the bat's wing. I had long admired Beale's famous slides of this tissue; but it will be remembered that he tore off the upper and lower skin, after long soaking in glycerine, and saved the middle tissue. Wishing, however, to save as much as possible, I scraped off the hair and pigment cells while the wing was in a solution of *liquor potassæ*. In this way, I saved many fine nerve-fibres and beautiful ganglion-cells, which do not appear in Beale's diagrams. These cells and nerves are brought out splendidly by the blue stain.

In a constant study of tissues for the past year, by means of this double stain, I have been continually reminded of the remarkably accurate work of Beale, especially as respects the demonstration of nerves.

For objectives in my own work, I have used a Tolles $\frac{1}{10}$ homogeneous,—a magnificent lens!—and a Tolles $\frac{1}{4}$. The latter was made especially

for histological work, with an angle of 95° —made for some investigations preliminary to a lecture on the formation of the tissues with special reference to the nervous system, and mar-

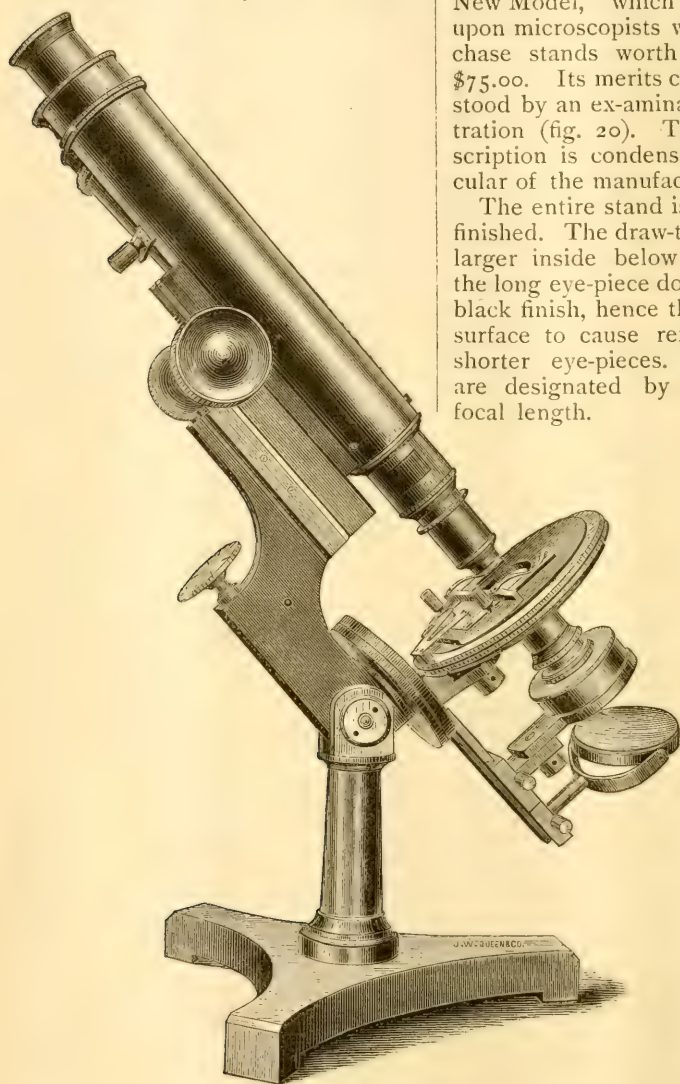


FIG. 20. -- THE "ACME" No. 3, IMPROVED.

The "Acme" No 3, Improved.

Messrs. J. W. Queen & Co. have recently introduced a new stand which they designate as the "Acme No. 3, New Model," which has many claims upon microscopists who wish to purchase stands worth from \$55.00 to \$75.00. Its merits can be fully understood by an examination of the illustration (fig. 20). The following description is condensed from the circular of the manufacturers:

The entire stand is of brass, highly finished. The draw-tube is turned out larger inside below the top, so that the long eye-piece does not rub off the black finish, hence there is no bright surface to cause reflection with the shorter eye-pieces. The eye-pieces are designated by their equivalent focal length.

vellous is the help which the superb lens has given to me in my histological studies.

BANGOR, Me., April 24th, 1883.

The rack-and-pinion adjustment has a long range. The fine adjustment is a very delicate and truly-working one, suitable for the highest powers. The

body is firmly carried upon rollers, and is moved by a lever actuated by a screw at the rear of the arm. The head of screw is graduated so that measurements of thickness may be made directly or by the application of a simple formula.

The stage is of black glass, with movable object-carrier held down by two ivory points, and has complete rotation. A plain brass stage, with rotating stage-plate and spring clips is furnished instead of a glass stage at a less price. Both stages have a standard screw-thread in the lower plate for the reception of selenite, which can be rotated independently of the Nicol's prism.

The sub-stage is movable on the mirror bar, is of the gauge most usually adopted, and carries an adapter having society-screw, for the use of objectives as achromatic condensers. To this is screwed the well-known "Acme" iris diaphragm.

The mirrors (plane and concave) are also adjustable on the mirror bar; the usual position is at the focal distance of the concave mirror from the object. Mirrors alone, or with the sub-stage, may be swung obliquely or above the stage.

Both stage and sub-stage are susceptible of centering adjustment by loosening the capstan-head screws which hold them in position, centering by hand and tightening again by a steel key furnished with the instrument.

The base (which is somewhat larger in the binocular form) is firmly attached to the pillar by a thumb nut.

Vibratile Cilia and Ciliary Motion.

(Continued from page 97.)

VIBRATILE CILIA IN PLANTS, OUTSIDE OF SPERMATIZOIDS AND ZOÖSPORES. — As early as 1838 Ehrenberg had asserted the presence of vibratile cilia in bacteria, particularly in *Bacterium triloculare*, and in *Spirillum volutans*; but as he, believing them

to be animals, had also attributed to them very complex structures (stomachs, etc.), naturalists for a long time denied the existence of the cilia, judging that his whole description was wrong, while in reality it was only partially so. Within a few years, however, commencing with the re-discovery of cilia in *Spirillum volutans*, by Cohn, the presence of these organs has been demonstrated in all true Bacteria, and in several species of Bacillus. Of those who have paid special attention to this subject, I desire to mention Messrs. Dallinger and Drysdale, who, after much labor, have demonstrated the presence of vibratile cilia in *Bacterium termo*, and also M. Warming, to whom we are especially indebted for researches in this direction. He claims to have seen two or three cilia existing on one extremity of *Ophidomonas sanguis*, *Spirillum volutans*, variety *robustum*, and in *Vibrio rugula*. The fact now rests without doubt that cilia are possessed by most families of bacteria. It would at first thought seem probable that the cilia of bacteria would be analogous to the vibratile lashes of other unicellular organisms — having for one of their functions, the propulsion of the body to which they are attached; but this seems not to be the case, for, according to the last-named observer, examples are often met with in which the body remains motionless while the cilia are in violent agitation, and others in which the body moves, while the cilia remain inert or dragging behind. Before making any attempt to account for this deviation from the general result of the vibration of cilia attached to free cells, it would seem best to have the fact corroborated by further observation. This, however, is difficult, owing to the extreme minuteness of the organisms and the appendages, as well as to the present limit of microscopical research, in regard to which Cohn says: "So long as the makers of microscopes do not place at our disposal much higher powers, and, as far as possible, with-

out immersion, we will find ourselves in the domain of the bacteria, in the situation of the traveller who wanders in an unknown country at the hour of twilight, at the moment when the light of day no longer suffices to enable him clearly to distinguish objects, and when he is conscious that, notwithstanding all his precautions, he is liable to lose his way."

Among the Cyanophyceæ, the Nostocaceæ possess vibratile cilia, covering those peculiar cells, called connecting cells or Heterocysts. The plants of this family are moniliform rows of cells, usually simple, though sometimes branched. These threads are free or inclosed in gelatinous sheaths, the greater number of cells are green and capable of division, but between them occur, at greater or less distances, or at the ends of the threads, colorless ciliated cells of considerable size, and incapable of division—the heterocysts. Individual cells without any apparent law may become heterocysts. They have been supposed to represent the antheridia of the higher orders of cryptogams. Passing from the Protophyta we find the next higher class of plants, viz., the Zygosporææ, exhibiting some interesting instances of vibratile cilia. Here we find the Volvocineæ, the conjugating cells of which are locomotive, and which are, during their vegetative period, continually in motion, interrupted only by certain periods of repose; the motion, as is usual with swarm-spores, being caused by two cilia. They are, however, distinguished from swarm-spores by the cells, which either live isolated (Protococcus and Chlamydococcus), or unite into angular and tabular (Gonium) or spherical families (Volvox Stephanosphaera Pandorina), being surrounded while in motion by a membrane through which the cilia project into the water, and produce by their vibrations the rotary progressive movement of the single cell, or the whole family. The Volvox globator, so common an object at microscopical exhibitions, is, perhaps, the

best member of this group for the student of ciliary movement to examine.

Right here we come to that little unicellular plant, Protococcus, the classification of which is in dispute. While this reproduces mostly by fission, it at times, after a period of rest, gives forth by internal cell-division, a motile form, provided with two cilia. This is the one most used for the demonstration of vibratile cilia in plants, since it is easily found, the cilia becoming distinctly visible as the plant approaches death, and the movements, for that reason, become less rapid. In this brief consideration of the leading examples of vibratile cilia in plants, we have seen, that as a rule, the period during which the cilia live and vibrate is short, existing in a few instances only, in adult plant life. Of the correspondence between the vibratile filaments of plants and those of animals, we have already spoken briefly; but we have every reason to believe that similar molecular particles produce ciliary motion in the vegetable kingdom as well as in the animal.

RATIONALE AND FUNCTION OF CILIARY MOTION.—Regarding the cause of ciliary movement, a variety of opinions have been put forward. Ehrenberg claimed that "each cilium was furnished with a bulb at the root, to which minute muscles were attached," a slight degree of rotation, communicated to the bulb, causing a much more extensive motion to the rest of the organ.

Valentin, Buhlmann, Friedreich, Eberth and others assert that the movements are dependent upon the contraction of the protoplasm in which the roots of the cilia arise. Klein and Prudden claim the movements are due to the contraction of introcellular reticular fibres; thus, the former says: "Supposing the introcellular net-work contracts to one side in a horizontal diameter, each such contraction acts naturally on the lower ends of the cilia, whereby they are pulled to the same side, while the

outer or freely projecting portions of the cilia are driven in the opposite direction, each cilium representing a lever, the short arm of which is within the cell in connection with the intracellular network, the long arm being the freely projecting part, and the fulcrum, or fixed point, lying in the membrane covering the free cell borders. When, in the next moment, the contraction of the intracellular net-work ceases, the cilia move again in the opposite direction. These two phases would correspond to the to-and-fro movement of the cilia." While it is quite possible to account for the simple variety of movement in the above manner, it does not seem to cover the case of the three or four more complex movements. A theory has however been advanced by Engelmann, applicable to all cases, and in my mind the most plausible of any thus far proposed. I cannot, therefore, do better than to quote his words in regard to the "Theory of Ciliary Motion," with which I fully agree:—"From the incomplete condition of our knowledge, and particularly from the deficiency of a closer insight into the chemical processes which play their parts within the cells and cilia, we are furnished with but a single foundation stone upon which to build a theory for ciliary movement. "As in protoplasm, attention is especially directed to a closer analysis of the obvious mechanical processes. In this connection, the following short remarks may be sufficient. It is essential that the performances displayed in protoplasmic movement should be here brought forward and made use of. We have to admit thereafter that ciliary movement issues, in all cases, from exceedingly minute elements, contained in the cilia themselves.

"These minute elements which, in a condition of rest are stretched out, and during contraction approach a spherical form, must be united in a firm arrangement, and all in like sense placed with their long axis parallel to the long axis of the cilium. Such

an arrangement may be preserved through the simple surface attraction of the elements, by a sufficiently small quantity of the intertegmatie fluids. Indeed one often sees, in consequence of the evaporation of the water, hyaline protoplasm, form itself into the finest cilia, or split up into fibrillæ.

"The changes of form in the inotagmen constituting a cilium must, as a legitimate consequence, be found to proceed from the base to the point, either rectilinearly upon the surface, or changing from the fore to the back surface of the cilium, (hook-shaped, wave-like motions,) or in a spiral turn, (funnel-shaped motion). The immediate cause of the changes of form in the inotagmen, should be sought in the changes in the conditions of distention (*quellung zustande*) of the same. The cause of this, that is, the physiological irritation, is due to molecular proceedings, of a kind not understood, starting periodically in the cell protoplasm, or (in the automatically moving cilia, e. g., many spermatozooids) in the substance of the cilium. Therefore, as the mechanism of ciliary movement is in principle to be regarded as identical with muscular movement, so, apparently, the proceedings which stimulate movements are identical with nerve incitation."

Coming now finally to the function of vibratile cilia and ciliary motion, the first thing that strikes us, is the constancy with which cilia are found in connection with the respiratory apparatus, from the lowest forms up to man. In the lower types they undoubtedly act as true respiratory organs, and up to the newt they are found still to retain this position, this creature being known to inhale water by the nostrils and discharge it by the mouth, twelve or fifteen times a minute, passing it in this way over the extensive tracts of ciliated epithelium in the nasal passages, mouth, and probably over those of the trachea and bronchi, although it is not positively known whether the water is drawn

into the air-vesicle or not. In this case the water is caused to flow over the ciliated surfaces, partially by a respiratory movement, and partially by the action of the cilia themselves: while, in lower forms (*Infusoria* and *Mollusca*, e. g.) it is renewed mostly by the latter means. Currents not dependent upon cilia are, however, seen in the sponge and in the stem and branches of *Sertularia*, which have no cilia, also as seen in the introcellular movements of fluids in *Chara*, *Vallisneria*, hairs of *Tradescantia*, &c. The cilia upon the outer surface of *Infusoria*, *Polypes* and *Medusæ*, as well as on various embryos, must be regarded as belonging to the respiratory system.

Besides acting as true respiratory organs, vibratile cilia act mechanically as a means of clearing the respiratory passages of foreign matter, mucus, dust, &c. The currents being in this connection always in the direction of the external surface (i. e. in the trachea, up: in the nasal passages towards the external meatus, in the frontal and maxillary sinuses towards their respective openings and in the lachrymo-nasal ducts towards the nasal cavities. Cl. Bernard experimented with a rabbit, by placing its head for some time in a bladder into which air was forced, containing large quantities of charcoal dust. He was unable to find any in the lungs, it being arrested by the cilia of the nasal passages and trachea. While the cilia undoubtedly act powerfully in this manner, they may at times allow the passage of foreign particles, as is seen in false pigmentation of lungs. This probably happens only when the cilia are overpowered by long continued exposure to dusty air, as in factories and mines. In the Eustachian tube the cilia prevent foreign matter from entering the middle ear.

To the respiratory function we find in *Infusoria* and *Mollusca*, (e. g.) added that of prehension of food. The vibrations of the cilia cause a vortex to be formed in the water, by means of which particles of food in the phy-

tivorous species, and smaller animalcules in the carnivorous tribes are brought to the mouth. In *Mollusca* the cilia may at all times be seen sweeping nutritive particles towards the entrance of the digestive tract. In *Infusoria* as well as in the *Ctenophora* and *Acalepha*, etc., cilia act likewise as locomotor organs, being in some cases, as we have before remarked, apparently under the control of the will.

Leaving the respiratory, alimentary, and locomotor functions of vibratile cilia, we find them filling a most important post in the processes of fertilization and reproduction. Both in plants and animals we see their constant attendance upon the process of fertilization. While in the reproductive organs of animals they render great mechanical aid towards bringing the unimpregnated ovule in contact with the fertilizing cell. Purkinji and Valentin found the movements in rabbits to be especially brisk in the fallopian tubes, less so in the cornua of the uterus, still less in the conjoined parts, and most lively on the lips of that organ, and of some strength in the vagina. The movement in mammals is in the fallopian tubes, towards the uterus, while in the uterus itself it is reversed, being from the cervix toward the fundus. According to Dr. Beck, (*Flint's Physiology*, p. 890,) at the occurrence of the orgasm in the human female, "the os opens, to the extent of fully an inch, making five or six successive gasps, drawing the external os into the cervix each time, powerfully." Here we see a provision of nature, compensating for the absence of cilia in the human vagina. This action of the os draws the male elements within the cervix when they come in contact with the ciliated epithelium, and are carried by its action as well as by their own vibrations, to the fundus of the uterus, when fecundation, as a rule, takes place. In other mammals (e. g., rabbits) where the sexual approach takes place only at periods of heat or rut, ciliated epithelium

exists in the vagina, but the human female is not thus restricted, and here we find the delicate ciliated epithelium replaced by a thick stratified permanent variety, better adapted to frequent insults. The ciliated epithelium of this region being limited to the tubular glands of the fornix, and introitus vagina. In the male sexual organs we find the ciliated epithelium of the vas efferens, coni-vasculosi, canal of epididymis, and beginning of vas deferens assisting its motile kinsmen the spermatozoa, through the tortuous and most difficult portions of their journey, and landing them at a part of the canal from which they can readily find their way to portions where they will be accessible to the emittent power of muscles concerned in placing them within the female.

We have yet to consider vibratile cilia in connection with two of the most important functions of the body, viz., the senses of hearing and smelling. In the membranous labyrinth of the semicircular and cochlear canals we find a variety of ciliated cells which has been called the neuro-epithelium, and their cilia the auditory hairs. These cells as they occur in the vestibule are spindle shaped, and are undoubtedly the bearers of the terminal organs of the vestibular nerves, which seem to be continued into their gradually tapering prolongations or cilia. In the organ of Corti we have two series of ciliate cells,—the inner and outer hair-cells,—the free extremities of which carry a thick tuft of staff-shaped cilia; in man very long and stiff.

These hair-cells number in man about 21,000,* constituting the most important or essential portion of the cochlear apparatus, carrying as they do the terminations of the auditory nerve. Several beautiful theories have been advanced to explain the part played by these auditory hairs in the appreciation of tones.

Hensen having observed that among

* 3,300 inner hair cells, 18,000 outer hair cells. — WALDEYER.

those of the crustacea some will vibrate to particular notes, just as when a person standing before an open piano sings any note, it is noticed that certain strings, corresponding in pitch, are thrown into vibration; considered that for each tone there existed a hair of the requisite length to answer its peculiar vibrations. It was, however, urged that the auditory hairs of mammals are of equal length, and therefore cannot act as organs for analyzing sound. It seems to me that this does not follow. We may readily see how difficult would be the task of distinguishing between different ciliated cells, were specimens of each variety to be placed at once under a cover glass and examined microscopically. Yet we know that each of these cells, in its proper position, performs functions peculiar to itself. It would seem to follow, from the independence of ciliate cells to the general conditions of the body, that there must be in each variety some difference in molecular arrangement. Thus bathed in the endolymph an auditory cilium selects from the complex vibrations of that fluid, such as are in harmony with its particular molecular arrangement. Allowing this to be the case, we can easily imagine the auditory cilia to be so constituted, that they respond only to certain tone vibrations communicated to them by the endolymph, and in their turn, communicating these vibrations to the nerve filaments which have become blended with or end in their substance. In the case of the cilia which in birds and amphibians are found in the olfactory regions, it is uncertain as to their position in regard to the nerve terminations; but it is settled that they represent no necessary condition to the perception of smell, since in mammalia and man they are wanting. When they do exist, their function may possibly be the mechanical one of drawing odorous particles into proximation with the terminations of the olfactory nerves. This seems probable, as they are known to have a motion of their own

in this region, in birds and reptiles, contrary to the cilia of the auditory cells, which seem to have lost their automatic movement and to be dependent upon special forms of irritation.

ROCHESTER, N. Y.

Evenings with the Microscope.

I

It is proposed to publish under the above heading, a number of articles especially intended for the beginner in the use of the microscope. Those who have attained more or less proficiency in microscopical work, know that there is never a dearth of material for entertainment as well as instruction always available. Yet many who, having their interest aroused by a glimpse of some of the wonders it reveals, forthwith purchase an instrument, soon lay it aside, because they find nothing new to examine. They find nothing new because they have not been guided in their search for it. Perhaps we may be able to show them that they need never search in vain. If in the dead of winter there is a dearth of insect and plant life without, there may still be found enough indoors to engage many profitable hours over the tube. This is especially true in the country, where in barns and sheds may be found, concealed among the rafters or sheltered under the eaves, cocoons, and nests of insects, and spider's webs, which, if examined with the aid of some good book as a guide, will well repay a careful search. On boards and trees will be found lichens and dried-up mosses, and here and there the brown or white excrescences, often several inches in breadth and thickness, which are fungus-growths, and green spores of algæ, with many other things well worthy of examination.

The first object we will describe is the eye of a common house-fly. The two large, hard, rounded prominences on the head of a fly are the com-

pound eyes. The usual way of preparing them for microscopic specimens is to first cut them out as carefully as possible, so as not to injure them, and place them in a strong solution of caustic potash, where they should remain until they become slightly softened, which will be in about twelve hours. The softening can be hastened by gently heating the solution. Then take out one of the eyes, wash it in water to remove the potash, then place it in a watch-glass on a piece of white paper, or in a small porcelain dish, and wash it thoroughly by the aid of a common camel-hair brush, until all the shreds of tissue are removed, and the chitinous portion of the eye is perfectly clean. This can only be known by examination with the microscope.

When perfectly clean, the eye is ready to be permanently mounted. For this purpose it must be spread out flat on the slide, and to do this without splitting the specimen requires great care. Trim off the edges smooth, and lay the specimen, rounded side up, upon a slip of glass about an inch square: cover it with another square of glass of the same size, and gently press the two together. If the specimen has been sufficiently softened by the potash, it will spread out quite flat. The two pieces should be then bound together by thread, and plunged into a bottle of alcohol. The alcohol removes the water and hardens the specimen, so that it retains its flattened form. It should remain in the alcohol, at least, twelve hours. It is then removed from between the glasses and transferred to strong carbolic acid for a few moments. A drop of Canada balsam is placed in the centre of a slide and the specimen is placed upon it, previously removing the adhering carbolic acid by touching it with blotting paper. By applying gentle heat, the balsam becomes very fluid and entirely envelops the eye; a thin cover-glass is then applied, the eye is arranged in

the centre, and heat is applied until the balsam becomes hard when cool. The excess of balsam is then removed with an old pocket-knife, and the slide finally cleaned with ammonia or alcohol.

In the above process we have departed from the usual course, by using carbolic acid. It will be found on very short experience, that carbolic acid is far superior to alcohol for mounting purposes. The acid is used in its strongest fluid condition, and it then freely mixes with balsam.

As thus prepared, the compound eye of a fly appears, under the microscope, as a great number of facets hexagonal in shape, each of which represents a single eye. The structure of insects' eyes is a subject too comprehensive to be treated at this time.

Another method of preparing the eye is as follows:—

Remove the eye as before described, and place it in the potash-solution for a few moments and clean it as before. It is not necessary to prolong the treatment with potash longer than is necessary to clean it well. After washing, transfer it to the carbolic acid, where it may remain until a cell is prepared for it. The eye is to be mounted in its natural shape, and a cell must be prepared deep enough to receive it. Such a cell may be made in various ways, but, perhaps, the simplest and quickest plan is this: Take a half-inch curtain-ring and flatten it somewhat by hammering it on a flat-iron; cement it to a slide by means of shellac dissolved in alcohol. Such a ring can be prepared in a few moments by drying the shellac over a lamp. When the shellac is well hardened, fill the cell with balsam, and place the eye within it, convex side up, place a cover upon it, and press out the superfluous balsam. Then cement the cover down by means of hard balsam dissolved in benzole. When this coat is dry, clean the slide, put a

coat of shellac over all, and then finish with any black or colored varnish.

As thus mounted the eye is adapted to the binocular microscope, condensing the light upon it from above.

There are many different kinds of eyes that may be prepared in either of the above ways. The second method is especially adapted to the mounting of opaque parts of insects. Thus, the entire head of a fly may be mounted in this way. Instead of balsam, glycerine may be used as the medium for mounting.

EDITORIAL.

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EXAMINATION OF WATER. — In the examination of water for sanitary purposes, the chemist is often at a loss to know whether there are living germs floating about in it, which his analysis cannot detect. This question frequently assumes considerable importance, and various methods have been proposed for testing the water—such, for example, as the addition of sugar and exposing it to the light. Dr. Koch, of Berlin, has proposed a method which promises to meet the difficulty. About $2\frac{1}{2}$ per cent. of gelatin is dissolved in a small quantity of water, and heated to kill whatever germs may be in the solution. It is then mixed with the water to be tested. On standing, wherever there is a spore capable of growing, it is held in suspension and forms a centre of growth which can be detected. The gelatin keeps a record, for a time, of the life in the water.

We have no doubt that some such method will be universally adopted by chemists in the near future. Already we learn from Prof. A. R. Leeds, who has been actively engaged in the analysis of waters for several years, that he has tried the process in his investigations, but with what success we are not informed.

It is said that occasionally there form in the gelatin, clear, spherical vesicles, from which a fluid may be withdrawn by a pipette. The bottom of such vesicles contains active bacteria.

APPARATUS FOR PHOTO-MICROGRAPHY.—Mr. George Smith describes an ingenious arrangement for photographing microscopic objects without an expensive camera, in the *British Journal of Photography*. He uses for a camera two boxes with sliding lids about fifteen inches long and five inches square. The ends of both boxes are knocked out and a sheet of heavy brown card-board is folded so as to fit the inside of the wooden boxes quite loosely, the two edges overlapping at the bottom. By inserting one end of this tube into each wooden box the sliding camera is complete. The inside is thoroughly blackened by vegetable black made into a thick paste with spirit varnish and then diluted with alcohol.

A board is then chosen the full length of the camera when extended, that is, as long as the two boxes and the connecting tubes together. The box which is to carry the optical apparatus is screwed down to one end of the board. The other box slides between two wooden guides, so that the camera can be shortened or lengthened at will, to increase or diminish the magnifying power. A cloth thrown over the arrangement keeps out the light perfectly.

The objective is mounted in the front box in a manner rather difficult to explain without a diagram, but we believe this can be left to the ingenuity of the reader, merely saying

that Mr. Smith fits the tube of a brass objective-box so as to slide in another tube lined with cloth. The bottom of the box is knocked out, and a society screw cut in the cover to hold the objective.

The sensitive plate, and also the ground glass for focussing are arranged at the back of the box at the other end in a convenient way, such as any person can devise.

The simplicity and cheapness of this arrangement will doubtless commend it to many of our readers. There should be some means of focussing the objective while the operator is looking at the image. This can be done by sliding the box out or in as required, but a far better plan is by means of a rod reaching to the front having a cord passing over a pulley moving a screw-adjustment for the objective.

Plates $3\frac{1}{4}$ by $4\frac{1}{4}$ inches square are a convenient and useful size, but larger ones are often desirable. A common size is 4 by 5 inches.

NOTES.

—Prof. S. A. Forbes has been experimenting on *amphipleura pellucida*, and he announces that he has obtained perfect resolution of that test in balsam, with a $\frac{1}{16}$ inch objective by Spencer, under remarkable circumstances. He writes: "My arrangements are the simplest possible,—a Bulloch 'biological' stand with the concave mirror, and any eye-piece from a 2-inch to a $\frac{3}{4}$ -inch. The light is that just outside of the disk of dazzling brilliance derived from sunlight. It makes no difference whether the mirror is strictly central, or whether it be swung laterally until that margin is central of it from which the rays used actually come, *i.e.*, about 10° ." In a later communication Prof. Forbes suggests that there may be some unknown reflections which produce this result, for while the resolution is perfect when the diatom lies transverse to the stage, they disappear as the direction is changed. The resolution is excellent with the mirror entirely darkened, except at a spot only 4 mm. (about $\frac{3}{16}$ of an inch) in diameter.

— A receipt for dammar varnish is given in *Science Gossip* as yielding a solution that will remain perfectly limpid. Add 8 fl. drachms of pure benzole to 4 drachms of crushed Indian dammar, and allow solution to take place without applying heat. Decant the clear fluid from the insoluble residue, and add to it 80 minims (1½ drachms) of spirits of turpentine. The purpose of the turpentine is to make the varnish tough. * The addition of mastic is of no value.

— Dr. Van Ermengem has obtained a preparation of Koch's *Bacillus tuberculosis* by filtering the air expired by a consumptive patient through gun cotton. By dissolving the latter in ether the bacillus was obtained, and stained by a proper method for demonstration.

— It has long been an opinion among microscopists that the best and strongest light for the illumination of microscopic objects is obtained by substituting a prism for the ordinary mirror. The advantages offered by the prism are more theoretical than practical, while the quantity of light reflected by a silvered mirror is far greater than can be obtained from a prism of equal size. The only advantage of the prism is the reflection from the single plain surface, while the mirror gives a reflection from both the outer and inner surfaces of the glass. But practically this is of absolutely no consequence. A well-silvered mirror reflects 95% of the light incident upon it. We will soon give a process for silvering glass which yields perfect results, and is readily applied by any person.

— Mr. E. C. Hansen has been studying the distribution of germs in the atmosphere, with reference to their influence upon fermentation in the manufacture of beer. He finds that the organisms in the air occur in swarms or clouds, with the intervening air quite free from spores. About the time of ripening of fruits the germs are most abundant. Under cherry trees, when the fruit was ripening, the yeast-fungus was found abundant in the air, while under grape vines, at the same time (the grapes not being ripe), the spores were not formed. In good fruit years the air is most full of germs. The air in one malt house was found to be more free from spores than the air outside—probably owing to the fact that the air was cooled and washed with a shower-bath of salt.

In other malt-houses the mould-fungi were very abundant in the air. These fungi exert a great influence upon the result of fermentation.

— Dr. A. Rollet has devised what seems to be a valuable instrument for spectroscopic research. It is to be used for examining objects in monochromatic light, and for the study of their properties of double refraction. It consists of a combination of a polarizer and a spectro-scope beneath the prism and an analyzing prism above the ocular.

— Prof. Abbe's new camera lucida is essentially the same as the new form lately devised by Mr. Grunow; but in Prof. Abbe's form the image of the pencil and paper is reflected to the prism over the eye-piece from a mirror supported by an arm which extends some distance from the ocular, so as to clear the base of the microscope.

— Mr. Aug. Gruber has described a new form of amœba—*Amœba oblecta*—which, not having any true shell, nevertheless forms a hemispherical case in which it lives, and extends its pseudopodia in all directions. We presume it should properly be classed among the forms with a shell, but the author has placed it in the germs *Amœba*.

— We have already referred to a new form of fine-adjustment recently perfected by Mr. Wenham and introduced by Messrs. Ross & Co. Mr. Swift has also introduced a very simple and effective fine-adjustment, on a different principle, which we believe is totally new. The adjustment-screw is on the left of the limb, moving horizontally and working a long vertical lever having a short arm at right angles at the top, which imparts a vertical movement to a rod attached to the nose-piece carrying the objective—not moving the main tube at all. It works admirably, and is a very cheap contrivance.

CORRESPONDENCE.

FISSION OF HYDRA.—In the April number of the American Monthly Microscopical Journal (vol. iv. p. 64.), Mr. T. B. Jennings notices a case of reproduction by fission in *Hydra*. Such cases are very rare but they have been noticed by Trembley, Rösel and Marsh all, the latter having seen three cases of this process.
J. S. KINGSLEY.

MICROSCOPICAL SOCIETIES.

At the annual meeting of the State Microscopical Society of Illinois, held at the Academy of Sciences, No. 263 Wabash Ave., on Friday evening, April 27th., the following officers were elected: President, Dr. Lester Curtis; 1st. Vice President, Prof. E. J. Hill; 2nd. Vice President, Dr. F. W. Mercer; Recording Secretary, William Hoskins; Corresponding Secretary, C. S. Fellows; Treasurer, W. H. Summers; Trustees, B. F. Nourse, C. O. Boring, B. W. Thomas, W. H. Bullock and H. A. Johnson, M. D.

At a meeting of the NEW YORK Microscopical Society held April 20th, Mr. A. A. Julien reported on the subject of Microscopical Mineralogy. Among the most interesting slides which he exhibited and explained, in illustration of his subject, were liquid carbonic acid gas inclusions in Quartz crystal. He spoke of the importance of not exposing the inclusions to the heat of the lamp as reflected from the microscope mirror, for more than a few moments at a time, since a longer exposure converts the liquid into a gas, thus rendering the object invisible.

NOTICES OF BOOKS.

A Manual of Photographic Chemistry, Theoretical and Practical. By Rev. T. Frederick Hardwich, M. A. Ninth Edition, edited by J. Trail Taylor, editor of the "Photographic Times and American Photographer," member of various societies, etc. New York: Scovill Manufacturing Co., 419 & 421 Broome St. 1883. (12mo pp. 464.)

For those who desire to know more about the chemistry of photographic operations than is found in the ordinary elementary books for the instruction of amateurs, this work can be most highly recommended.

Both collodion and gelatin processes are treated at length, and in truth it may be said that the work is a treatise on photography as well as a manual of photographic chemistry. It is to amateurs that we are indebted for many valuable improvements in photography, and the publication of this book — the popularity

of which is evident from its having reached a ninth edition — has undoubtedly opened the way to many of them, by indicating the direction in which experiments might be profitably conducted.

The plan of the work is a good one. The different chemicals employed are first described; then follows an account of the action of light on salts of silver, the development of the invisible image, and then a great deal of information about different photographic processes in general. The book is written for photographers, who are not presumed to be chemists, hence it is adapted to the understanding of all readers.

In the last part of the work is the most complete treatise, of a strictly elementary and popular character, on the optics of photographic apparatus, to be found. In this part we think we discover the work of the able editor who is an acknowledged authority upon that subject, as well as upon all other matters relating to photography.

Exchanges.

WANTED.—*Trichina Spiralis*, *Pleurosigma Ang.*, or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

FOR EXCHANGE.—Well-mounted double-stained vegetable preparations, also, a few first-class injected preparations for other well-mounted slides. N. A. Richards, St. Louis, Mich.

WELL-MOUNTED slides of *Polycystina*, transparent and opaque, for any well-mounted slide. P. C. Cole, M.D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 108 Virginia St., Richmond, Va.

DIATOMACEOUS MATERIAL and Histological slides for other well-mounted and named slides of *Foraminifera*, Animal Parasites, Pathological subjects, etc. R. Cauch, M.D., Carpenteria, Cal.

FOSSIL DIATOMS from Carson, Nev., and Fosa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

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BOSTON, JULY, 1883.

No. 7.

The Action of Tannin on the Cilia of Infusoria.

At a meeting of the Royal Microscopical Society, on March 14th, Mr. Henry J. Waddington read a valuable article, from which we have condensed the following summary: In trying the effect of various chemicals upon infusoria — principally *Paramecium aurelia* — a solution of tannin, or tannic acid, was used, which immediately rendered the cilia visible, without manipulating the light.

On placing a drop of water containing the paramecia upon a slide, with a minute quantity of solution of tannic

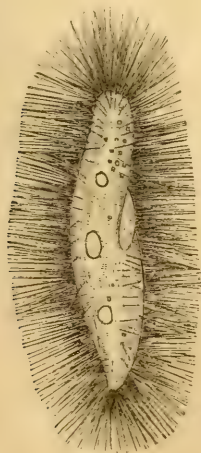


FIG. 21.

acid and causing the liquids to flow together, the instant the paramecia approach the mixed fluids their motion is arrested. The cilia then gradually become more and more distinct, until

the body of the animalcule seems entirely surrounded by them.

If the solution of tannin is too weak the cilia are not immediately arrested in their motion, and they then appear more or less crossed and crumpled as in fig. 21; but if the solution is of the proper strength they stand out straight, as in fig. 22.

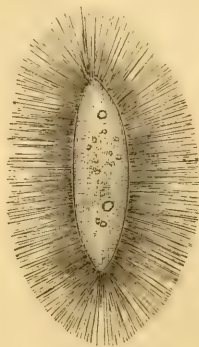


FIG. 22.

It is recommended by the author to examine the infusoria with a paraboloid, after this treatment.

The tannin, unless the solution is quite strong, does not instantly kill the animals, for the contraction and distention of the contractile vesicles may be observed for some time.

The solution of tannin used is made by dissolving one part of tannin acid in four parts of glycerin.

Mr. Waddington also uses a solution of sulphurous oxide gas * in alcohol.

A minute quantity of the alcoholic

[The method of preparing this gas can be found in any treatise on chemistry; the old name of the compound is sulphurous acid gas. —Ed.]

solution added to water containing infusoria, causes the ciliary action to become visible. Too much kills the animals instantly. The author believes that this reagent will prove of great value in microscopical investigations of infusoria.

Address to the Members of the Royal Microscopical Society.*

BY PROF. F. MARTIN DUNCAN, F. R. S.

Every Fellow of this Society who has attended the evening meetings during the last twelve months must have been struck with the very practical nature of our proceedings, and that the observations made, and the apparatus exhibited and described on those occasions, indicated a growing desire for the perfection of the microscope. At the same time it must have been evident that the application of the instrument to its proper purposes is open to many sources of error, and that there is an amount of intelligence and knowledge required in the management of the microscope, which is the result of much labor, thought, and experience. Common sense might tell everybody this, but it sometimes happens that when a man has invested a certain number of guineas in an instrument, he imagines he is correspondingly endowed with the abilities of a microscopist in the true sense of the term. On the other hand a very large number of able men become possessed of instruments humble in appearance and not costly in any sense, and they rest satisfied that a microscope is a microscope, and believe, therefore, that they see the true invariably. One of the benefits of belonging to our society is the opportunity of seeing objects properly shown by the ablest manipulators, and of hearing communications on the imperfections and

corrections of the instrument, and it would be well if our list, full as it is, were crowded by those scientific men who constantly use the microscope in original research in biology. A considerable experience impresses me that the majority of students, and not a few professors, not only use indifferent instruments, but also carefully avoid all those practices which we know are absolutely necessary for correct microscopy. A thing is seen, therefore it must be real; one man sees a spiral line, another a circle, another a series of dots, using the same object and different microscopes. They describe and debate, and each is self-satisfied. Yet all the while had they had a master in microscopy their differences could be terminated.

A pleasant evening with the microscope generally means a painful time for the eye. A good glare of light, thanks to lamp, condenser, mirror, and forgotten diaphragm, appears to be almost invariably a desideratum to the beginner. Experience teaches, however, and the advanced microscopist never uses more light than is absolutely necessary, and increases and diminishes the illumination during the careful observation of an object, not only by employing a less intense source of light, but also by using diaphragms of different sizes.

Since microscopy has been extended to the examination of sections of rocks composed of different minerals, the truth that some can be roughly distinguished by their dichroism under the polarizing ray, the analyzer not being used, has become apparent. The polarizer is also useful in another manner. Researches have been undertaken to examine into the influence of the polarizing ray upon substances which may or may not give the usual phenomena under the analyzer. Polarized light carefully manipulated, is very useful in examining thin sections of corals, which are made up of closely placed fusiform and long alternating prisms,

*From *Microscopical News*;—abstract from the *Journal R. M. Society*.

with geometrical prisms of carbonate of lime in planes one over the other, and often radiating from different points. Shadow and high light succeed when the Nicol is rotated, and minute details become apparent which are not seen, or are only feebly defined, by ordinary light reduced in its intensity to that of the polarizing ray by the use of diaphragms.

Some time since, in investigating the structure of a fossil which was composed of close radiating and occasionally inosculating tubes with very thin walls and a distinct lumen, all mineralized with calcite in the glassy, non-crystalline form commonly seen in fossils where there is much space unoccupied by structure, the polarizing ray certainly made the tubes more distinct than the ray reflected from the mirror alone, and by rotating the substage Nicol, the position of certain tubes which were invisible before could be ascertained; that is to say, dark lines appeared limiting tubes, which were invisible under ordinary illumination.

The application of the whole polarizing apparatus is very useful in working at the minute superficial structures made up of thin and highly refractive plates of organic carbonate of lime. The glare of light under ordinary illumination, and even when the polarizer only is used, prevents the true surface being focussed, or if it is fortunately hit upon, it is more or less invisible. But the analyzer being placed across the direction of the polarizing ray the true surface can be found by the definition and distinctness of the clear colors and the intermediate lines. Take away the analyzer, and often new structures appear to the eye. As a matter of practice I find that this method is exceedingly useful.

Circumstances have brought me in contact with cheap microscopes, and certainly whilst it may be said that some of the objectives are fairly good, the eye-pieces are on the miserable "par" with the rest of the

apparatus. I cannot avoid believing that during the next few years attention will be paid to increasing the merits and adaptability of eye-pieces whatever may be their special character.

In the address which I had the honor of delivering to you last year, I remarked upon the comparative values of object-glasses with high and low numerical apertures, and I took pains to defend the employment of lenses with wide apertures in examining minute objects, and also to state that both kinds of objectives are necessary for investigating into the structure of minute objects. I suggested what has commended itself to every advanced microscopist for years past, that an observer should provide himself with both classes of objectives, and that he should use those with a moderate aperture for common and preparatory work, and those with a high numerical aperture for subsequent and careful examination.

Very few microscopists care to correct their objectives during ordinary work, and principally because they have not seen the difference made in the appearance of an object by the process when it has been carefully carried out. But when an object, hitherto unsatisfactorily defined, presents itself under a clear and definite aspect, conversion to the opinion that there is an absolute necessity for correction in all delicate investigations regarding minute structures speedily ensues. There is no doubt that with very few exceptions the microscopic work relating to the morphology of the animal and vegetable kingdom has been conducted either without corrected objectives, or with those which have an average adjustment. I pointed out in my last address how abnormally thick, slender and excessively minute bodies appear under a high amplification; this is partly due to a want of correction, and mainly to another cause which is not necessary to advert to. Now, I have no hesita-

tion in saying that similar abnormalities are constantly recorded as truths, and for that same reason which causes excellent observers to differ in a most remarkable manner, about the appearances of the same object under different microscopes. It has been put very forcibly by Dr. Dippel, that if the shape of the object is unknown, correction may be a mistake, and that when the focus is at a lower plane than the summit of the object, correction may positively mislead.

There is no doubt that an image seen under a certain correction, and which is stated to be normal, is modified by under- and over-correction. How to get at the truth is difficult, except in the instance of geometrical bodies and definitely parted lines, but the examination of the same object by many observers with different instruments gives experience; and without indulging in calculations, including the method of least squares, it is finally settled that such and such is the real shape.

The possibility of error remains, however, and it is perfectly evident that many a difference of delineation of carefully investigated objects results from non-correction and over- and under-correction. One cannot but help thinking that the difficulties in correcting dry objectives of high amplifying power and great numerical aperture, will lead to the almost constant employment of immersion objectives. And really the only researches which are rendered more difficult by the immersion principle are those which have rendered the name of Dr. Dallinger so illustrious. There is no doubt that it is impossible to prevent the admixture of the medium with the water below the thin cover when minute organisms are followed here and there and often close up to the edge of the glass cover.

Amongst the results of not correcting objectives are want of definition, haziness, and the production of certain colors; and this last phenomenon is often observed in objectives which

are corrected up to a certain degree and fixed. It is the fashion to correct and fix so as to obtain a certain amount of chromatic aberration, a ruby tint being considered the best. This is to obviate the effect which the perfect achromatism of a glass of large numerical aperture has on the eye.

There can be no doubt that the majority of the recorded histology of the minuter structures, will have to be worked over again, with carefully corrected objectives.

In concluding these remarks on the microscope itself, I must enter a protest against the clumsy method of pushing a glass slide, with a valuable and important object upon it, with the fingers, under the objective and moving it about. Cheapness of the instrument and want of scientific care are the temptations to, and the causes of this very frequent source of error, which is intensified by the common fault of want of perfect flatness of the plane surface of the stand.

The beautiful adaptation of a sliding glass restricted by a point, whilst it relieves the microscopist from the expenditure involved by a complicated brass movement, is so easily fitted that there is no excuse for employing the fingers alone.

Instructions in Dry-Plate Photography.

(Concluded from page 109.)

To make transparencies for the projecting lantern requires considerable practice, and the exercise of good judgment concerning the printing density of the negative. The beginner need not be discouraged if he spoils two dozen plates or more in making one dozen good transparencies. The loss will be made up in the valuable experience gained.

There is no doubt that the best and cheapest transparencies are made with collodion. Nevertheless, it is a fact that excellent transparencies can be made with dry plates, and these are

so convenient to use, that the additional cost becomes a secondary consideration, when amateurs desire to make a few slides to illustrate a subject for an evening's lecture.

The proper size of plate for use in lanterns is the so-called "quarter size"—measuring $3\frac{1}{4}$ by $4\frac{1}{4}$ inches. We recommend for transparencies Carbutt's "A" plates, because they are not so sensitive as others in the market.

The developer used is made as follows: 1. Dissolve 4 ounces of potassic oxalate in 16 ounces of water, acidify with citric acid until blue litmus-paper is reddened by the solution, then add 100 grains of citric acid.

2. Dissolve 2 ounces of ferrous sulphate in 8 ounces of water, and add 8 drops of sulphuric acid. When ready to develop, add one part of the iron solution to four ounces of the oxalate.

The negative from which transparencies are to be made, should be clear, strong, and with good detail. Place the negative in a printing frame. If no printing frame of the proper size is at hand use a large one and put a plate of clear glass in it, upon which the negative may be laid. Then go into the dark room, put a sensitive plate down upon the negative, and put in the back of the printing frame. For this work a piece of dead-black cloth should be placed over the back of the sensitive plate to obviate reflection, which might seriously impair the result. If the springs of the printing frame will not catch without applying under pressure, hold the back in with the fingers; but be sure to apply sufficient pressure to insure good contact between the negative and the sensitive film.

The plates are then held up to the light of a candle or lamp or gas-flame, and the greatest care must be taken not to expose them too long. As a rule, five seconds will be a long exposure, at 18 inches from an ordinary gas-flame.

When the exposure is made, develop

the plate. The development should be quick, and it must be watched with the greatest care. It is essential that the picture should come out leaving the glass around it perfectly clear. The moment the development begins to show where the glass should be clear, remove the plate from the pan and wash it. Then proceed with it just as though it was a negative.

When the negative is quite thin it is a good plan to cover it with white tissue paper before making the exposure. This diffuses the light, and often greatly improves the transparency.

The great tendency of beginners in this kind of work is to make pictures that are too dense. For a lantern very little density is required. If the detail is good that is all that is desired. It will all show on the screen, even though it seems too weak on the glass.

There is also a great tendency to expose the plates too long. Three or four seconds seems a very short time for printing, but it is usually quite sufficient. Mr. George E. Davis has even made a good transparency with an exposure of only twenty seconds to the light of a small alcohol lamp. It is true he used a more sensitive plate than the ones here recommended, but the experiment shows what actinic force there is in a very weak light.

A few words now about the applications of this process. Those who have used the projecting microscope, are well aware of the difficulties in the way of its general use even in halls of small size. High-powers cannot be used with it with any satisfaction, and instead of being able to select objects to illustrate a lecture, the lecture must be, to some extent, arranged to conform to the capabilities of the lantern. We do not imply that this will always be so. But, taking the facts as they are at present, it is certainly much better to use photographs of microscopic ob

jects, taking either from the objects themselves by aid of the microscope, or else from good wood-cuts — which is often the better plan — than to grapple with the difficulties in using the projecting microscope. We regard the latter as a useful instrument for popular demonstrations, and, no doubt, it has a limited sphere of usefulness in more strictly scientific work, but until it is greatly improved in several respects, it cannot be of very great value to lecturers upon scientific subjects,

A Large Microscope.

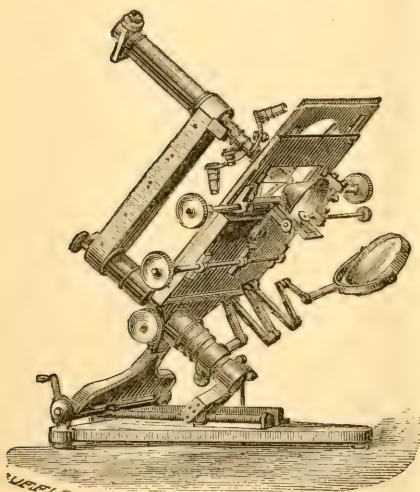


FIG. 23. —DR. DEECKE'S MICROSCOPE.

Many of our readers have heard of the large microscope used by Dr. T. Deecke, of the New York State Lunatic Asylum for the examination of large sections of the entire human brain, and for other purposes. These celebrated sections sometimes measure nearly six inches in diameter, and not more than $\frac{1}{400-600}$ of an inch in thickness. We take pleasure in giving an illustration (fig. 23), of Dr. Deecke's microscope, taken from the *Journal of the Royal Microscopical Society*.

It was made in 1876. The mechanical stage is 12 inches square, hav-

ing 8 inches motion. The ingenuous method of inclining the instrument, by means of a screw at the base, will be readily understood from the figure. The arm carrying the tube is $13\frac{1}{2}$ inches in length. A slide 10 x 8 inches can be laid on the stage.

Evenings with the Microscope.

II. MULTIPLE IMAGES. CRYSTALS.

In a preceding article were given instructions for mounting the eyes of insects in balsam. Perhaps on the whole it is better to mount them dry. The process for cleaning them is the same as that previously described, the only difference in the whole operation being in the mounting on the slide, which will now be described.

First we would allude to the preparation of insects' eyes for showing multiple images, that is, so that each facet of the compound eye will act as a lens, forming an image of an object placed behind it at its conjugate focus, so that in the microscope may be seen an image in each of the tiny lenses.

To do this it is only necessary to clean the eye thoroughly, which had best be done with water and a brush, and then mount it dry.

The convex form and chitinous nature of the eye makes it rather troublesome to mount. It should be spread out flat on the slide, but in order to get it flat it must be cut around the edges, otherwise it will be sure to break, and irregular cracks will extend across it. So make a few slits inward around the circumference, dry the specimen thoroughly, and then place it in the centre of a clean slide having a thin ring of plain shellac already hardened upon it, upon which the cover-glass may rest. The object of this ring, is to prevent any cement that may be applied, from running under the cover. Now apply a fresh coat of shellac to the ring, and immediately put on the cover-glass. Then flatten the eye out by applying a

brass spring compressor, or else by laying a heavy leaden bullet on the cover-glass. After a while it will be found that the shellac holds the cover securely. Then put on one or two more coats of shellac, and when these are hardened finish the slide with asphalt varnish.

To produce the multiple images requires a little patience. The best eyes for the purpose are those of a large beetle; but many other objects besides eyes will also give miniature images in the same way. Place the slide upon the stage in the usual way, and focus upon it. Now, it will be understood that any image that may be formed by the eye will be a short distance above the eye, so withdraw the objective until the eye is slightly out of focus and it will be approximately focussed upon the plane of the images.

The object to be miniaturized may be either transparent or opaque. As transparent objects are most easily managed, it is advisable to begin with them. Select any object that may seem suitable, for example, a small mounted insect, or a transparent photograph, such as is to be found in almost every cabinet. The Lord's Prayer can be read in each one of the single eyes if the proper adjustments are made, or a comic picture can be shown there. Whatever object is selected, place it somewhere between the mirror and the stage, and and throw the light through it to illuminate the object on the stage. The light must be strong and properly directed, and the distance of the transparent object from the stage must be adjusted for the best effect. Focus the objective upon the images of the object formed by the eye, not upon the eye itself.

It would be useless to give more detailed instructions than we have given above. It is not an easy matter to get the best effects until one has some practice,—then it becomes a very simple matter.

To miniature opaque objects in this

way is much more difficult, because of the strong light required. A favorite object with some persons is the moving second-hand of a watch, which can be shown very beautifully. For this purpose the face of the watch must be covered with dead black paper, leaving only the dial of the second-hand exposed. The second-hand itself should be large and black to be seen well. The watch must now be substituted for the mirror of the microscope, the second-hand being in line with the optical axis of the tube.

If a strong light is now condensed upon the second-hand by means of two bull's-eye condensers, it will, when properly adjusted, show clearly in each facet of the beetle's eye.

We propose to say a few words about crystals here, mainly to direct attention to the ease with which they may be prepared as beautiful objects for the polariscope. The subject is too large to be treated at considerable length in this place. Perhaps the few remarks that may be made will bring forth some inquiries concerning points not touched upon in this article, in which case we shall be most pleased to answer to the best of our ability.

It is always a beautiful sight to watch crystals forming under the microscope, and with the polariscope and selenite plate, the effect is still finer. Almost any of the readily crystallizable compounds will do for these experiments. Bichromate of potash is good without the polariscope, borax, sal-ammoniac, tartaric acid, etc., give fine effects with it, but among the alkaloids, the salts of quinia, are noted for their fine crystals for the polariscope. Santonine and salicine dissolved in alcohol or chloroform and allowed to crystallize on the slide, produce beautiful effects. All these may be made to crystallize while we look at them, but the best effects can only be obtained by experimenting with solutions of varying strength.

For permanent slides, select only

the very finest specimens. Do not keep any others, because in making such slides they rapidly accumulate, and soon one has too many.

It will be found that great variety in the crystals can be obtained by heating the slides, previous to placing the solutions upon them, or by heating them during the process of crystallizing. Another way of controlling the crystallization, which often gives rise to the beautiful radiating groups of crystals found in the shops, is to add to the solution some gum arabic, or some "soluble glass." As a rule, the more rapid the crystallization the smaller will the crystals be.

Many crystals may be mounted dry, but if they will bear covering with Canada balsam, they are all the better when mounted in that medium, especially for polariscope effects.

Very beautiful crystals may be obtained by the sublimation of white arsenic. We have long contemplated writing an article on this subject, but it must be still deferred. However, the process in outline is simply this: place a small quantity of arsenic in a watch-glass, or on a slide, and gently heat it, holding another slide above it so as to condense the fumes. If the operation is properly conducted, most beautiful and perfect crystals will be found upon the upper slide, when it is examined with a microscope. In this way very minute quantities of arsenic may be detected.

Microscopic Objects at the Fisheries Exhibition.

The great International Fisheries Exhibition now open in London at South Kensington, is far more comprehensive and complete than any previously held. Being devoted exclusively to fisheries, there is comparatively little to be seen of the minute forms of life which especially interest microscopists. Such as we have been able to find will be here briefly described.

In the United States department, under the charge of Commissioner G. Brown Goode, there is more microscopic material than in any other. Taking up first the fresh-water organisms, there is a fine collection of slides by Mr. Edward Potts, of Philadelphia, illustrating the various species of sponges found in fresh-water in America. In most cases each species is represented by three slides, one showing the dry sponge as an opaque object, the other a section or a thin portion mounted in Balsam, and finally a slide of the spicules. Many of the genera might be readily identified by the spicules alone. It may be of interest to know what species and varieties Mr. Potts has distinguished, so we will enumerate them in the order they occur in the collection. The first is the *Spongilla paupercula* of Bowerbank, which has smooth, curved spicules tapering toward both ends. *Sp. aspinosa* has similar spicules. Then comes *Sp. lacustris*, with large spicules still of the same kind, mingled with numerous smaller ones covered with spines or minute projections. It may be put down as a rule that when two kinds of spicules are found on a slide, the smaller ones belong to the gemmules of the sponge. Several varieties of *lacustris* are represented, viz., *media*, *mutica*, *Dawsoni*, *Montana*, and *multiforis*. In the next species, *Sp. fragilis*, Leidy, the spinous spicules are larger and rather more straight. The varieties of this species are *Ottawaensis*, *minuta*, *minutissima*, *irregularis* and *Lordii*.

The genus *Meyenia* is represented by some very fine specimens. *M. Leidii*, of Bowerbank is a beautiful sponge, the dried specimen appearing like a mass of minute, incrusting cones, formed of glassy spicules arranged around a central aperture in the apex. The spicules of the gemmules are very curious, resembling two thin, parallel plates, slightly concave outward, connected by a short thick axis. These are very minute,

requiring a power of 200 diameters to show them well. In *M. fluviatilis* the large spicules are of considerable size, spinous or warty, while the smaller ones have a short, thick axis terminating in disks of radiating spines at both ends. This is a very common form of spicule, which may be conveniently designated as biradial. Of this species there are two varieties, *astrosperma* and *acuminata*. In *M. robusta* the large spicules are smooth while the others are quite spinous and large. *M. crateriforma*, Potts, has slender spicules and the biradial ones are long and slender. The spicules of *M. Everetti*, Mills, resemble those of the preceding species.

Heteromeyenia repens, Potts, and *H. argyrosperma*, Potts, show the gemmules beautifully in the dried specimens. The latter species has one variety, *tennis*. *H. Baleni*, Potts, has also a beautiful cup-shaped gemmule, and in *H. Ryderi*, Potts, the gemmules appear to be dotted all over with minute foramina, and the spicules are very beautiful.

The genus *Carterius* is represented by two species *C. tenosperma* and *C. Fanshawei*, Potts. This genus is characterized by a tubular projection from the pore in the center of the concave side of the gemmules, with terminal root-like branches. Of the remaining forms we need only give the names, *Tubella reticulata*, Bowerbank, *T. Pennsylvanica* and *T. Fanshawei*, Potts; *Farmula Batesii* and *Brownii*, and finally *Urngwaya coraloides*, Bowerbank. The reader will observe, from the above list, that many species of sponges have been discovered quite recently, for not long ago it was supposed that there was only one species of fresh-water sponge, which was named *Spongilla*.

Mr. Hitchcock has a number of slides of selected foraminifera on exhibition, and a number of specimens of eggs of fishes and crustacea preserved by the method mentioned in these pages, a short time ago. We have

since learned that the fluid used in preserving the specimens is a mixture of alcohol, glycerine and water, but the proportions are not made public. A much larger collection of these specimens is shown in the British section.

Mr. Thomas Bolton's exhibit is always surrounded by a goodly number of persons waiting for a peep through the microscopes. He has shown many specimens, some of them quite rare. Among them we may mention the *Stephanoceros Eichoruii*, the "crown animalcule" which is not considered as common in America; the worm recently discovered by Mr. Bolton and named *Haplobranchus æstuarinus*; the cyclosis in the proembryo of *chara*; some young smelts, only 12 days old, hatched by Sir James Maitland in 42 days in his hatching house, at a temperature of 42° F.; the sea-mouse *Polynæ cirrata*; the rare rotifer *Floscularia coronetta*, and in one of the aquaria he has a nest of the stickleback, in which some of the eggs have hatched.

Notes From Abroad.

We have already published a few notes under the above heading, which we very much fear will show great evidence of having been hastily put together. Since writing them we have had an opportunity of visiting some of the eminent microscopists of England, and a few words concerning their method of work will certainly prove of interest.

Mr. E. M. Nelson, of London, is acknowledged to be one of the most expert manipulators with the microscope in the city. He has a "studio" devoted entirely to microscopical work, and, being a gentleman of ample means and leisure, he devotes a great portion of his time to the examination of objectives and experimenting on different methods of illumination. It is, indeed, a pleasure to observe the dexterity with which he works, for

among many excellent observers there are few who can handle a microscope so neatly and quickly as Mr. Nelson.

Entering the "studio" one afternoon we found that daylight had been effectually excluded, and several microscopes stood ready, with lamps lighted, for inspection. The first object we examined was a *Heliopelta* — the beautiful diatom figured in Dr. Carpenter's book — with a $\frac{3}{8}$ -inch objective. It was on a dark field, just as we have often shown it ourselves, but there was a peculiar beauty about it which was soon explained. It was illuminated with a Powell & Lealand achromatic condenser, the light being so adjusted that the most perfect dark field effect was produced, in combination with a polariscope and selenite plate, which imparted just the faintest tinge of blue to the light. The diatom was not shown as a polarizing object; the polariscope was used merely to color the light, and thus impart a faint hint of color to the frustule — so faint, indeed, that it was just noticeable, but it was enough to make the object stand out with remarkable beauty and distinctness. Some other diatoms shown in the same way were also very fine objects for display.

We may allude to the care with which Mr. Nelson adjusted the light for the dark field, not because there is anything novel about it, but because our attention was particularly drawn to the matter, and many persons, perhaps, have not thought of it. The source of light was a common flame of an oil lamp, placed edgewise to the mirror. In order that the achromatic condenser should give a round spot of light on the slide and not an elongated image of the flame, a bull's-eye lens was used in front of the flame to render the rays as nearly parallel as possible. To get the best effect of illumination upon a minute object like a diatom, the distance of the source of light from the mirror must be so adjusted that the spot of light from the achromatic condenser

focussed upon the object, will be as nearly as possible of the size of the object. No doubt this fact is often overlooked in using condensers for dark-field effects. Obviously the further the light is removed, the smaller will be the image formed by the condenser.

The importance of careful illumination, in Mr. Nelson's opinion, is evidenced by the fact that he has a fine adjustment attached to the substage of his microscope for focussing the condenser. Another refinement he has adopted in his stand is to have the eye-pieces of his Wenham binocular stand, accurately adjusted so that the images in both tubes shall be magnified precisely alike. We doubt if this is worthy of any special attention.

With a $\frac{1}{2}$ -inch objective by Powell & Lealand, of numerical aperture 1.43 (balsam angle 140°) Mr. Nelson showed the longitudinal lines of *Amphipleura pellucida* so that we were able to faintly distinguish them. The resolution, however, was far from satisfactory, and we are promised a future opportunity of seeing the lines under better conditions, when we are assured that there will be no difficulty in detecting them.

The podura-scale was shown with a $\frac{3}{4}$ -inch, water-immersion of Zeiss, with polarized light, but this object has already been referred to in these columns. A fine object for exhibition was a *Pl. formosum*, shown with a Powell & Lealand $\frac{1}{4}$ -inch objective and lieberkuhn. The lens was of 95° angle and had a very long working-distance. The magnification was carried up to 900 diameters.

Of course we saw the transverse lines of *A. pellucida* with the fine lenses in Mr. Nelson's hands. The great advantage of the slightly increased angular aperture of the $\frac{1}{2}$ -inch of 1.43 n. a. over the $\frac{1}{3}$ of 1.38 n. a., both by Powell & Lealand, is strikingly shown by the resolution of that diatom.

We observe that the favorite method of showing the lines on the *A. pellu-*

cida in England, seems to be with the vertical illuminator, and that is used so as to throw a line of light into the field just covering and illuminating the diatom, leaving the rest of the field dark. This is done by taking the light directly from the edge of the flame, without interposing a condensing lens between the flame and the illuminating reflector.

When Mr. Nelson suggested to cut away sections of the screw-threads of the objective and nose-piece so as to quickly attach and detach the former, we felt very doubtful if the plan would be regarded with favor by microscopists generally. Our doubts have been fully confirmed by what we have seen. Nevertheless, the plan is a most excellent one, and the best evidence we can offer of our faith in its value, is that we propose adopting it ourselves as soon as we can obtain the templates, or a copy of them. The ingenious "facility nose-piece" devised by Mr. Pease, of Massachusetts, which we have had the pleasure of first exhibiting in London, has been received with great favor. This instrument, and also the new camera lucida of Mr. Grunow, with some excellent objectives by Messrs. H. R. Spencer & Co., a $\frac{5}{8}$ - and a $\frac{1}{8}$ -inch, "professional" series, were shown by us at a meeting of the Royal Microscopical Society.

The international fisheries exhibition was opened in London on the 12th of May, and we are pleased to say that the exhibit of the United States, in charge of Commissioner G. Brown Goode, and his able assistants, is a most creditable one, and in many respects more complete than any of the others. There is a fine collection of slides from Mr. Potts, of Philadelphia, illustrative of the fresh-water sponges; some beautifully mounted specimens of algae from Prof. Farlow, and a few embryological specimens entered by the writer. In the British section Mr. Thomas Bolton has arranged some fresh and salt-water aquaria

with living microscopic specimens, sponges, polyzoa, hydroids, infusoria, and various other objects, which he exhibits and explains with the aid of several microscopes. There may be much more of interest to microscopists in the exhibition, but it is too early to learn just what is to be seen, for there is yet much to be done before the collections are all properly displayed.

At a recent meeting of the Quekett Microscopical Club, at which, however, we were only able to be present for a few moments, we saw a few living specimens of the recently discovered fresh-water medusa *Craspedacustes Sowerbeyii* or *Limnocoedium Victoria*. It was discovered in the *Victoria regia* tank at Kew Gardens, where it has been found in considerable abundance.

At a meeting of the Royal Microscopical Society Mr. Crisp announced that Mr. J. D. Müller has prepared a type-slide of 1600 diatoms, which any person can obtain for about \$400.00.

At the same meeting Mr. W. Watson exhibited a new microscope, which he acknowledged to be a copy of Mr. Bulloch's "biological" stand.

Mr. G. E. Davis has shown us some very fine photographs of microscopic objects, designed to be used with the lantern for projecting upon a screen. One was of a *Pleurosigma angulatum*, which was far more perfect than we supposed it would be possible to obtain from the object. In fact it leaves nothing whatever to be desired, and the dots are as clearly defined in the transparency as they are seen in the microscope.

Another fine plate shows the *Volvox globator*, as natural as life. This slide was made by Dr. Maddox. How he killed the plant, and caused the the balls to retain their form and position we do not know, but doubtless osmic acid was used, and perhaps some staining fluid. We would not have supposed that such a good lantern-slide of *Volvox* could be made

from the microscope, and the results we have seen lead us to believe that it is quite possible to make very good lantern slides from photomicrographs of even such difficult objects as foraminifera and polycystina.

On Mounting Diatoms in Lines and Patterns.*

The following instructions are given by Mr. H. Sharp, who has prepared some beautiful slides:—

The requisites are: (1.) One or two cat's or mouse's whiskers fastened on match-like sticks or fine rushes, with shellac rather than gum, with about $\frac{1}{4}$ inch free. I prefer to have one with the natural point, and another with the point cut back to where it is somewhat stiffer. (2.) A good simple microscope of some kind, either attached to a roomy stage-plate, with a mirror below and revolving plate above, or detached on some stand, cut capable of being brought over a mounting-table with mirror and rotating plate as above. My own is home-made, extremely simple, costing nothing but the trouble, and such as any one with a little ingenuity could make for himself. It consists of a piece of pine 9 inches long, 5 inches wide, and 1 inch thick, on three legs, with a hole in the centre, into which a wooden matchbox (with the bottom cut out) fits tightly, projecting a little above; over this fits a piece of slate just tight enough to rotate easily; beneath, a peg receives the mirror of the microscope. This forms the detached mounting-table. For the simple microscope, I take the foot and tube-pillar of the condenser, fit a piece of cane in this tube, drive a pickle-bottle cork stiffly on it, and fasten on this a horizontal wooden bar with a hole in the middle to fit on the cane, and another at each end in which to fit the lenses, which are just the $1\frac{1}{2}$ inch and $\frac{1}{2}$ inch ob-

jectives, which give far better definition than common pocket-lenses. (3.) A steady hand. (4.) Patience and perseverance.

All diatoms and scales should be mounted on the cover, not the slide. Lay a clean cover on a slide and keep it in place by a drop of water between. As scales are larger than diatoms, it is well to begin with them. Put several on a slide in the ordinary way, pick out the ones wanted with a bristle under the simple microscope, one at a time; keep the cover flooded with moisture from the breath, and deposit the scales picked up wherever wanted in lines or patterns. They will readily leave the bristle for the wet glass, and can be pushed about quite easily. When the moisture dries off no stain is left, and the objects will adhere with sufficient firmness to resist anything short of a sharp jar. When the line or pattern is finished, mount in a shallow cement cell.

The cover must have a film of a gelatinous nature which is insoluble in balsam and its solvents. A thin aqueous solution of isinglass carefully filtered serves well. A single drop is placed on a clean cover and spread out as thin as possible with a clean needle. It dries almost instantly in warm weather, and in a few seconds in winter. A diatom placed on this film and gently breathed on is securely sealed, and cannot be dislodged without moisture. Care must be taken to place the diatom in position while the film is quite dry; then breathe on it; allow the film to dry again; then place another diatom, and so on, till the line or pattern is finished. If any of the diatoms are thick or likely to be crushed, stick three bits of cover-glass under the edge of the cover with gum, and place a dot of gum on each before placing the cover in position on the slide. This, when dry, will keep the cover in its place, while introducing the balsam, before doing which, allow a little benzine to run under by capillary attraction,

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which soon displaces the air from the diatoms. Then apply a little balsam to the edge of the cover and a bit of blotting paper to the opposite edge. This draws away the benzine, and the balsam follows and takes its place. Another plan is to gum a piece of good cream-laid paper on the slide, centre on the turn-table, and make two cuts through the paper, removing the middle and outer portions and leaving a rim of paper to form a cell as large as the cover; then cut two small openings in opposites of the ring, gum the top of the cell, and place the prepared cover on the gummed surface. When dry apply the benzine to one of the small sluiceways, and then balsam as before. Put the slide in a warm place for several days, and finish off with white, black, or colored varnish to fancy. Winter is the best time for dry mounts, as the breath dries off too soon in hot weather; and summer is the best time for balsam mounts, as it is difficult in the winter to keep the breath from moistening the isinglass at the wrong time. The cement-cells should be quite dry and hard before mounting, or a dewiness will appear and ruin the object. Soften the cement over the lamp, press the cover down till it sticks all round, let stand a day or two and finish off. No doubt the diatoms would be more secure if burnt on the cover in the dry mounts, and possibly that process would be sufficient for the balsam mounts without the film of isinglass, as stated on p. 68 of Davies' "Manual of Mountings."

—Dr. E. Klein has observed a pink *Tornia*, which appeared in a solution of pork broth with which he was conducting some culture-experiments. It appeared to be identical with cells of *Saccharomyces cerevisiae*, or common yeast, but when seen in masses they have a pink color. Under the microscope they do not appear colored. The color only develops in the cells that are exposed to the air—those growing beneath the surface are quite colorless.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

TO SUBSCRIBERS.—We regret to learn from the publishers of the JOURNAL that many subscribers have not yet paid their subscriptions for the present year. Subscriptions are due, as all readers well know, in January, and it is wrong to expect publishers to give six months' credit for small sums like one dollar. It is no more than right that they should stop sending the JOURNAL to those in arrears, as they have expressed the intention of doing; but we have suggested that it might be a better plan to offer a special inducement to prompt payment by increasing the price of subscription to \$1.50, but making it \$1.00 for payment strictly in advance. All readers of this JOURNAL know that by taking the paper out of the Post-office they are legally responsible for the subscription, but there is a moral responsibility also which should make a notice of this kind as unnecessary as it is out of place in a scientific journal.

We do not know what plan will be adopted by the publishers, but we are assured that if readers desire to receive the JOURNAL regularly they must pay for it promptly. We trust those in arrears will attend to the matter immediately.

WHATEVER short-comings the readers of the JOURNAL may observe in the Editorial department, during the Editor's absence, will, he sincerely hopes, be amply compensated for by the improvement of the JOURNAL in other ways upon his return.

He is pleased to be able to announce that he has already succeeded in making some arrangements, while in London, which will greatly enhance the value of the JOURNAL to many readers. It is also not improbable that after his return he will be able to devote more time to the congenial work of editing the JOURNAL than has been possible in the past.

During his absence he has been most kindly and efficiently aided in preparing the paper by Mr. Jno. L. Wall, of New York, who has read all the proofs, and arranged the matter for each issue. If Mr. Wall had not freely consented to do this work, which has surely made considerable demands upon his time, the Editor would have experienced far more anxiety about leaving than he did. Under these circumstances the thanks of the readers as well as of the Editor are due to Mr. Wall for his assistance so freely rendered.

THE APERTURE SHUTTER.—There has been considerable difference of opinion among microscopists concerning the value of the "aperture shutter" as it is called, which is nothing more than an adjustable diaphragm fitted to the nose-piece of a microscope just above the objective. It is made by Mr. Charles Collins, of great Portland Street, London, with a society screw so as to be readily attached to any microscope. Mr. Collins advertises it "for giving penetration to objectives." Mr. George E. Davis published an article some time ago in the *Northern Microscopist*, in which he endeavored to prove that the use of the aperture shutter does increase the penetration of an objective, without injuring its definition. The ground thus taken by the author, which was well sustained by the engravings of two photographs of polycystina, taken by an objective with its full aperture and when its aperture had been reduced by means of the shutter, was supposed to be in direct opposition to

the results of Prof. Abbe's calculations. Prof. Abbe had said that the use of diaphragms above an objective to reduce the angular aperture would destroy the perfection of the definition. Mr. Davis endeavored to prove that it was not so, and he certainly succeeded in doing so, in the particular case illustrated in his article.

We do not propose to enter into the theory of the subject, but the question presented is one of no little practical importance. It is probable that both Prof. Abbe and Mr. Davis are right, for we believe that while Mr. Davis has been experimenting with lenses of low power, Prof. Abbe's results applied to objectives of high power, in which the conditions are quite different.

The practical question that interests every working microscopist concerns the influence of the shutter upon the penetration of low-power objectives. In the case of all others the penetration to be gained from the objective itself, apart from the power of accommodation of the eye, in any way is, theoretically, so very little, that it is scarcely worth striving for. But with low-powers the effect may be very noticeable.

An examination of the subject, with Mr. Davis to make the demonstration, has fully satisfied us that the aperture shutter does greatly increase the penetration of a low-power objective. We mean by this, an objective of not more than a half-inch focal length. The increase is very strikingly shown in certain opaque objects. Polycystina show it very well. The increase in penetration seems due to the shutting out of light coming from some of the upper portions of the object, which tends to confuse or over-power the vision of the deeper portions.

The evidence in support of the increase of penetration can be most satisfactorily demonstrated by photography. Whatever increase is observed in a photograph is entirely due to the effect of the shutter upon the objective. We have seen the photographs which Mr. Davis has made to

sustain his position, and they are conclusive as to the facts, whatever the explanation may be.

We may add that all objectives do not bear a reduction of aperture without loss of definition. In a few cases it has been found that the shutter cannot be used with them. But such cases are quite rare exceptions to the general rule. For example, a Wales's $\frac{3}{8}$ -inch of 30° would scarcely stand any reduction. We believe this is also the case with some of the objectives of Zeiss that have been tried.

MOUNTING WITH WAX.—Mr. Jno. E. Fawcett has described the following method of using wax in mounting, in the *Microscopical News*:—

My process is to get a spirit lamp and place it under a dish supported on a retort stand. Into the dish I pour white wax, or bees wax, and melt it. It requires making very hot, and the lamp to be left continually under the dish. If the slide is to be opaque, I cut a piece of black paper to about the size of the cell to be made, and attach it to the slip. I then put it on the turn-table, and build up the cell with the hot wax. Of course it is allowed to overlap the paper background and the glass, and thus make a neat cell. It has the advantage of being built up to any thickness at once. There is also no untidiness of the paper not fitting the bottom of the ordinary vulcanite cell, or if it is placed on the underside of it, being scratched off. Then again, if the background is put at the back of the glass slip, it is invariably bright instead of dull. When the slide is dry and ready for sealing up, all that is necessary is to place the cover on it and put it once more on the turn-table, when one turn, with the application of the wax brush, is sufficient to make it a permanent mount. It can then be finished with the usual varnishes. I have described it for opaque dry mounts, but the process can be equally well used with transparent dry mounts.

I also use the wax to help to fill up the sides of balsam cell-mounts, between the closing cement and the finishing varnish. In adopting this plan, the wax must be kept very hot, and the brush should be left in it when not in use.

THE AMERICAN SOCIETY OF MICROSCOPISTS.—Being so far away from home when writing these few words about the August meeting of the Society, merely to remind our readers of the meeting, and to urge upon them the advantages which are offered by gatherings of the kind for social intercourse, as well as for the interchange of ideas between persons from different parts of our great country, we are unable to give any particulars concerning the meeting this year. Prof. McCalla, the President, informs us that the meeting promises to be a very large one. We trust it will be. The State Microscopical Society of Illinois has a large number of members who will, we are confident, do all in their power to make it a success, and to extend Western hospitality to all visitors—may we say even to those from St. Louis, the only rival which Chicago fears!

Although we cannot be present at the meeting, we will endeavor to report the proceedings promptly in these columns, as has been our custom heretofore.

SYNOPSIS OF DIATOMS.—The plates of this excellent work of Dr. Henri Van Heurck, are now all published and in the hands of subscribers. Considering the nature of the illustrations, and the labor it must have required to collect and arrange the material for them, we would congratulate the author for having completed the work so quickly, and in such a satisfactory manner. Subscribers will notice that there is still a volume of text to come. The most we can say about that, is that it is to be published next year.

Meanwhile Dr. Van Heurck is en-

gaged in preparing a series of "Types of the Synopsis," of which he says in his prospectus:—

"The figure the most exact, the description the most complete, does not give so perfect a knowledge of an object as does the view of the object itself. The author of the "Synopsis" believes, therefore, to render service to *diatomophiles*, and more especially to *débutantes*, by publishing a series of microscopical preparations representing the principal types of the "Synopsis" and elucidating the species, etc.

There will be about 350 preparations, containing 400 or 500 forms. Besides diatoms of Belgium there will be specimens from fossil deposits, such as the Rappaneck, Barbadoes, Richmond, etc., which have been figured in the plates.

Twenty-five preparations in a neat case, will be published each month, beginning in July. The price for each set of 25 preparations cannot be announced at this time. The price in Belgium is, or rather has been, 25 francs, to which must be added the duty, and transportation charges which cannot be estimated. Orders may be sent to the Editor of this JOURNAL who will fill them at the lowest price possible to subscribers to the JOURNAL.

OCULARS. — If a number of eye-pieces are subjected to examination, it will probably be found that many of them are far from being as perfect as they should be. Take a piece of paper ruled in small squares and examine it by looking at it through the oculars reversed. Probably many of the oculars will show the squares greatly distorted. This is mainly owing to the fact that makers have departed from the proper formula for placing the lenses in relation to their respective focal lengths. There is no doubt greater attention will be given to the construction of oculars in the future, for the subject is already receiving

attention in England. Mr. Bulloch has measured the focal lengths of many oculars, and no doubt he has records in his possession which would tell to what extent the original, and also the best, formula has been departed from, in setting the lenses.

A NEW FINE-ADJUSTMENT. — Mr. Wenham has devised an entirely new fine-adjustment for microscopes, which we can most unhesitatingly say seems to be the acme of perfection for the purpose. It is devised on a totally new principle, and has been applied to the large Ross stand, now in the possession of Mr. Frank Crisp. We are not yet at liberty to explain the mechanism, but our readers will hear more about it at an early day.

A "SCIENTIFIC EVENING." — On the evening of May 2d, the Royal Microscopical Society, of London, held what is known as a "scientific evening" at King's College. The scientific evenings are distinguished from the regular meetings by the informal nature of the proceedings. These evenings are designed to afford an opportunity for the members of the society to examine objects on exhibition. To avoid overcrowding, visitors are not admitted, except by the consent of the President and Council.

As the editor was so fortunate as to be present on the occasion referred to, he has prepared a few notes upon some of the objects exhibited. But in the beginning it may be said, that the plan of having certain evenings set apart for the sole purpose of exhibiting objects especially for the mutual benefit and instruction of members, is worthy of adoption by similar societies in this country. It will readily be understood that when objects are selected for public exhibition, quite different considerations will influence their choice than those which would prevail were the selection to be made for the edification of persons

associated in the same, or allied branches of investigation.

One gentleman, whose name we did not learn, showed the beautiful *Conochillus volvox* in a way that revealed its form and beauty far better than we have ever seen it at any exhibition in this country. The colonies were placed on a slip having a concave centre and covered. In this way they were held in place so as to be constantly in view, while forced to revolve, and to move about within narrow limits. The illumination was with the paraboloid. We may remark that the use of the paraboloid for showing living objects, seems to be more common in England than here. Mr. H. J. Waddington showed some fine specimens of *Melicerta*, with very perfectly formed tubes. These objects, although familiar to all, deserve special mention for the excellent manner in which they were shown.

Mr. F. Enock showed the leg of a honey-bee mounted without pressure. It was a very beautiful preparation, and we would strongly advise those who have not tried that method of mounting, to take this as an object for experiment.

Mr. Powell showed the *Amphipleura pellucida* with a $\frac{1}{25}$ -inch objective of n. a. 1.38, using an achromatic condenser. Also with the same objective he showed some other diatoms and the podura-scale. The latter was very beautifully shown.

Mr. E. M. Nelson, showed the podura-scale with a Zeiss $\frac{1}{25}$ -inch, water-immersion, with the polariscope. The appearance of the scale thus shown, with central light, is quite remarkable. Mr. Nelson also showed the *Pleurosigma fasciola* resolved very beautifully into dots, with central light.

Mr. Hailes, who has mounted some exquisite slides of foraminifera, from a collection that must be very rich and valuable, showed some of his specimens with a Stevenson erecting binocular. This binocular gives a very excellent effect, and for arrang-

ing such objects under a low power it possesses very great advantages. Many other objects were shown, but we cannot extend the list.

Dr. Maddox exhibited an apparatus for drawing a slow current of air through a filter for arresting the suspended germs. The quantity of air was measured, and an estimation of the relative number of germs in the air at different times can thus be made. The instrument consisted essentially of a modified sprengel mercury air-pump, in which water instead of mercury, was used to carry down the air. The germs are collected on a glass coated with a thin layer of glycerine, against which the air is caused to impinge as it enters the apparatus. The glycerine retains the spores in a condition for immediate examination. The apparatus is very easily constructed by any person, by the use of glass and rubber tubing, and such other materials as are always at hand. The fall of the water was, we should think, about four feet.

NOTES.

—The resolution of *A. pellucida* by central light, mentioned in these columns, was made by Prof. S. A. Forbes, by sunlight. The resolution has also been made by artificial light, and Mr. E. M. Nelson, of London, states that any of the homogeneous-immersion objectives in use will resolve the lines with central artificial light. There is no reason to doubt the truth of this observation, especially since we have had the pleasure of seeing the lines clearly resolved by Mr. Nelson's manipulation. Nevertheless, the ease and distinctness with which the resolution was made by Prof. Forbes is surprising; for it must be admitted that oblique light is necessary, with our best lenses, to show the lines distinctly.

—While on the subject of resolution we may add that Mr. Nelson does not approve of oblique light for resolution. He prefers to use central light in the study of markings on diatoms, because oblique light often shows lines when central light

shows dots—hence oblique light is misleading. One need not look far to discover a fallacy in the argument thus suggested. Apart from the fact that the true structure of an object showing very minute striæ cannot be inferred from its appearance in a microscope, it is well known that the capability of resolution depends upon angular aperture, and it is impossible to utilize angular aperture without angular illumination. Whatever resolutions are effected by strictly central light, are, nevertheless, due to angular light, whether the light enters the lens from an illuminator of wide angle, or from the brightly illuminated object itself.

—It is, we believe, a very general opinion that the green color of oysters, sometimes observed, is due to a vegetable growth,—parasitic plant. Mr. J. A. Ryder has not been able to find any evidence of a vegetable parasite producing this color, nor does he believe that the coloring matter is chlorophyl. The color seems to be in the blood-cells, but whether derived from some derangement of the normal condition or not, is not known. It is not unlikely that the nature of the food may have some influence in producing the color.

—The latest catalogue from Mr. Carl Zeiss is much larger and more fully illustrated than any of its predecessors. It contains figures of the microscope-stands with full descriptions, and a list of the objectives and their magnifying power, but the arrangement has been changed, and some additional information added to this part. Mr. Zeiss now makes a corrective-adjustment for his homogenous immersion lenses, but the object of the adjustment is to correct for the varying length of tube, and not for different thicknesses of cover-glasses.

—Dr. Vincent Harris has published an account of some experiments in double-staining blood-corpuscles, in the *Quarterly Journal of Microscopical Science*. Among the various combinations he has used, the following seem to be the best:—Rosin and iodine green. This stains colored corpuscles bright red, with bluish-green, nuclei. Colorless cells were of three varieties, *viz.* those staining entirely green, those becoming yellowish red with green nuclei, and large masses of nucleus-like bodies, said to be developing colorless corpuscles, which become of a

deep green. Fuchsin and methylen blue. This combination is highly recommended; it seems to be best of all, unless fuchsin and soluble blue be excepted as equally good. The method of staining is this: dry the corpuscles in a thin, even layer on the cover-glass, then cover them with the red dye, wash in water, apply the green or blue dye, wash, dry, and mount in balsam.

—Mr. Washington Teasdale, of Leeds, England, who has done some very fine work in ruling on glass, has prepared a slide for testing the illumination of a spot-lens, paraboloid, and condensers with stops. To get the best results of dark-field illumination it is necessary to have the light strike the object from all sides alike, but it is not always easy to know when the light is properly adjusted. Mr. Teasdale uses a slide ruled with bands of lines, not very closely ruled, crossing at various angles. By examining such a plate with a spot-lens or paraboloid where the light comes in from all sides the lines are all equally bright on a dark ground, but when the light is unequally adjusted some of the lines are dull or almost invisible.

—Those who, from economy, or for pleasure, make their own accessories, may utilize a suggestion that comes from Mr. Teasdale for making a spot-lens. A good-sized glass fish eye, such as can be obtained from dealers in naturalists' supplies, mounted in a piece of cork, makes a very satisfactory spot-lens indeed.

—Messrs. Ross & Co., have just come into possession by purchase, of all the Dauguet optical glass left by the death of Mr. Dauguet. The peculiarity of this glass which makes it especially valuable for optical purposes is that perfect achromatism can be obtained with a double convex line of equal curvatures on both sides. It is also regarded as purer than any other glass, because it is made in an open crucible. Messrs. Ross & Co., have been very fortunate in securing a large quantity of this valuable material.

—Mr. J. Grunow has improved his camera lucida by a slight change in the size of the opening through which the image of the object on the stage is seen. By reducing the opening to a diameter of $\frac{1}{100}$ of an inch, he states that the pencil point is still more clearly seen, while sufficient light comes from the object to show the details.

—Mr. Charles Coppock, who has recently established himself in an elegant store in Bond Street, London, has issued his first catalogue of scientific instruments, which is quite fully illustrated. Mr. Coppock does not intend to confine his business to selling microscopes of any one make, but he proposes to furnish any instruments that may be desired. We notice in the catalogue a list of Tolles' microscopes and objectives, Bulloch's microscopes, and we understand that Mr. Coppock has taken the agency for Spencer's objectives.

—Among the new accessory instruments we notice an "objective-screw micrometer" which is for the purpose of measuring objects too large to be seen in the field at one view, and an ocular-micrometer consisting of a plate of glass with divisions ruled upon it placed in a Ramsden ocular, with a graduated screw-head. Two forms of the Abbe condenser are figured, and an ingenious arrangement for illumination with monochromatic light, as well as a spectropolarizer. The last two instruments we will more fully describe in a future article in this JOURNAL.

—Mr. Thomas Curties, has called our attention to some slides illustrating the embryology and structure of minute marine organisms, which are worthy of more than a passing notice. They are prepared by a new method, the details of which we do not know, but the rotundity of form and the living appearance are remarkably well preserved. Among the slides we have seen are eggs of fishes, and of crustacea, fishes only one day out of the egg, minute crustacea of various kinds preserved whole or in parts, and a few vegetal preparations. All of these were preserved with surprising perfection, and we are thereby led to hope that even delicate algæ may yet be preserved in all their beauty of form, if not in color. These preparations can be obtained from Mr. C. Baker, optician, of 244 High Holborn, London.

—Mr. W. Miller finds that the microphyte *Leptothrix buccalis*, which has been regarded by some as causing decay of teeth, occurs in three distinct forms—as coccus, bacillus and the spiral form. This organism enters the teeth after acids have dissolved the lime of the enamel and dentine. The author asserts that a growth resembling *Saccha-*

romyces mycoderma sometimes perforates the enamel of sound teeth. The active agents in the decay of teeth he regards as bacilli and micrococci which may be found deeply penetrating the substance of teeth undergoing decay.

—Homogeneous immersion objectives have had their day—at least in the hands of one English microscopist. It seems the gentleman to whom we refer took one of those lenses home to try. He understood that it was a good lens for resolutions. He tried it, but soon returned it, saying he would not have it in his house. It would hardly resolve *P. angulatum*! But the worst of it was his sad experience with the immersion fluid. Lavishly used, it dissolved the varnish of his pretty slides, and spoiled their beauty. It got on his pocket-handkerchief and imparted to it an odor of some essential oil that stood by him for a week. The lens, and all lenses of its class, received his most unqualified condemnation.

—Messrs. Ross & Co., have at last succeeded in reducing the cost of manufacturing the new Wenham binocular prism so that they are able to introduce it. Heretofore the difficulties in the way of making it have been an obstacle which at one time led them to give it up entirely. Even now the price will be about three guineas for each prism. This prism we may remind the reader, is for use with both high and low power objectives. It fits in the same place as the ordinary Wenham prism, and takes in the entire field of view—not dividing the field like the common prism, but dividing the light like the prism in Abbe's binocular ocular. The prisms are cut at three angles for tubes having a divergence of 13, 14, and 15 degrees respectively.

—Although a pair of scissors is not strictly a microscopic object, yet we have seen several pairs that were probably not made without a microscope. At the show-rooms of the Messrs. Rogers, Cutlers to Her Majesty, in Sheffield, there is a delicate balance under a glass case, in one pan of which there are twelve pairs of perfect scissors, which are overbalanced by a half-grain weight on the other side.

ERRATA.

By a typographical error in the June issue, the name of Mr. J. F. Hazlewood was used instead of Mr. T. F. Hazlewood, as writer of the article on "Histological Work."

CORRESPONDENCE.

DARK FIELD ILLUMINATOR.

TO THE EDITOR.—In the first number of the *American Quarterly Microscopical Journal* is a drawing and description of a new dark-field eye-piece, by Prof. Lighton, of Ottumwa, Iowa. For some two years I have been using this very important piece of apparatus in my studies of larvæ, and its work is so surprising and new that I would suggest that you give to the microscopists of the country, through the Monthly Journal, a reprint of the drawing and description in question. This dark-field arrangement is not generally known and the workers with the microscope that have seen my eye-piece have been so interested in it that I thought best to request its republication.

The plan is applied to one of Gundlach's Periscopic one inch eye-pieces as used by me. T.T.T.

OMAHA, May 15th.

[The suggestion of our correspondent will receive early attention.—ED.]

MICROSCOPICAL SOCIETIES.

The N. Y. Microscopical Society has adjourned for the summer.

A new Microscopical Society was formed in Binghamton, N. Y., during the past month, of which Charles F. Mills-paugh, M. D., is President, W. H. Proctor, M. D., Secretary, and A. J. Butterfield, M. D., Cor. Secretary.

The society has our best wishes, and we hope to hear from them from time to time.

The Royal Microscopical Society, of London, has made the President of the American Society of Microscopists an *Ex-officio* Fellow. Prof. Albert McCalla is, therefore, an *Ex-officio* Fellow of the Royal Microscopical Society.

The Sixth Annual Meeting of the American Society of Microscopists is to be held in Chicago, beginning Tuesday, August 7, 1883, and continuing four days.

Very extensive preparations have been made by the local societies for the entertainment of the visitors, and full pro-

vision will be made for illustration of papers and exhibition of objects, apparatus, etc.

The Thirty-second meeting of the A. A. S. will be held at Minneapolis, Minn., August 15-21, 1883. The President of the section of Histology and Microscopy, is the Hon. J. D. Cox, of Cincinnati, and the secretary is Dr. Carl Seiler of Philadelphia. A large attendance is expected.

A cordial invitation is extended to all interested in microscopy. The President is Albert McCalla, Fairfield, Iowa, D. S. Kellicott, Ph. D., Buffalo, N. Y., Secretary.

Exchanges.

FOR EXCHANGE.—Slides of pollen of pitch pine, *Pinus rigida*, with the connection stained, for any named slides of algae. Dr. C. F. Mills-paugh, E. M. S., Binghamton, N. Y.

WANTED.—Trichina Spiralis, Pleurosigma Ang., or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

FOR EXCHANGE.—Well-mounted double-stained vegetable preparations, also, a few first-class injected preparations for other well-mounted slides. N. A. Richards, St. Louis, Mich.

WELL-MOUNTED slides of Polycystina, transparent and opaque, for any well-mounted slide. P. C. Cole, M.D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 108 Virginia St., Richmond, Va.

DIATOMACEOUS MATERIAL and Histological slides for other well-mounted and named slides of Foraminifera, Animal Parasites, Pathological subjects, etc. R. Cauch, M.D., Carpenteria, Cal.

FOSIL DIATOMS from Carson, Nev., and Posa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

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No. 8.

The Punctations of Diatoms.

The observations of M. Prinz* differ from the remarkable studies of Flögel, O. Müller and Green, in that those observers do not admit that the interior layer of the valve is perforated.

According to these observers, the valves completely separate the contents of the cells from the exterior. Müller made his observations particularly on *Triceratium favus*, with the aid of an ingenious method of submersion. In this species (and in many others similar to it, such as *Biddulphia reticulata*, and the triangular form of that species common in the Pacific Ocean); the inferior layer is certainly covered with fine punctations disposed in radiating lines, which do not fail on any part, and thus exclude the presence of large openings. It is true, one might admit that these minute points correspond to small canals traversing the inferior layer of the valve. But I have examined very large specimens of *Triceratium favus*, var. *septangularis*, which possess an inferior layer sufficiently thick to allow, by changing the focus, the observation of radiate punctations on the internal face, and of short spines irregularly distributed over the external face, situated at the base of the hexagonal alveoli; the walls of the latter are thick, and present spinous projections at the angles. In *Coscinodiscus* structures analogous to those of *Triceratium favus* are met with, and even *Tricer-*

atium consimile, Grün., very similar to *Triceratium favus*, possesses exactly the structure of *Cosc. oculis-iridis*, so that the conclusions which apply to one of these species may be well extended to the others.

As concerns the *Cosc. oculis-iridis*, the inferior layer has circular depressions and not perforations. The valve is very thin in the depressions, so that ebullition, or other violent treatment, perforates them completely at these points. But an irrefragable proof is furnished by *Cosc. asteromphalus*, so closely allied to *Cosc. oculis-iridis* that it is often difficult to classify the intermediate forms. In that the interior side of the valves is covered with minute points (depressions) disposed in such a manner as to form upon the border of those depressed points, a crown of large punctations becoming smaller and smaller, and more difficult to observe, towards the centre, but always covering the base of the depressions. By raising the lens out of focus these minute punctations disappear, and in their place are seen the large circular depressions, considered by M. Prinz as perforations. *Cosc. gigas* is also very interesting. In it one only finds small depressions in the middle; toward the border, these are surrounded by depressions directed toward the exterior, so that this species possesses at the centre the structure of punctate forms, and at the margin the structure of *Cosc. oculis-iridis*, *radiatus*, and others similar.

In *Trinacria Regina*, it is true, the depressions penetrate very deeply toward the base, as in many diatoms. But at the bottom of these depressions is found a smaller concavity, which,

* Remarks of M. Grunow with reference to the work of M. Prinz, translated and condensed from the *Bulletin de la Soc. Belge de Microscopie*.

with good objectives, can be distinctly seen in the midst of the pores; this structure is common in diatoms. I have a large specimen of this species in which a very fine and close punctation seems to exist on the internal face of the valves. The section of *Cosc. excentricus* (or more likely *Cosc. symbolophora*), given by M. Prinz, appears to be very accurate; the canals of the pores are in great part shown to not reach the internal face of the valves.

M. Prinz,* after reading the criticisms of Mr. Grunow, called to mind that his observations were made upon material provided by Mr. Mauler, at the time of the publication of a memoir of Mr. J. Deby "On the Microscopical Appearances of Diatoms," and of a note by Dr. Kaiser on the photographs of *Pleurosigma angulatum*. He said: "I hoped, by means of thin sections of rocks placed at my disposition, to verify the observations of those authors. I thought it would suffice to announce the results obtained by this mode of preparation to induce diatomists to take part in the study of certain delicate questions of *organographie* and of structure. The few details into which I then entered (and of which I hope to be pardoned for the imperfections due to imperfect notions upon the subject) had no other aim.

"I may be permitted to remark that my honorable opponents have drawn their principal arguments from facts observed under other conditions than mine, and resulting from the examination of different species than those I have described; which leads to suppose that I have applied the results of my researches to the structure of all diatoms. I believe, on the contrary, that many species present details of structure which do not correspond to the conformation of other species resembling them in appearance.

"The details of structure of the *Pleurosigma angulatum*, appear to me too

complicated and of a nature too delicate to decide the question. The thinnest sections of this species have at least two series of pearls or pores. The silicious frustules which contain these designs show in section the image of two continuous traces, one interior and the other exterior. It is this that led Mr. Flögel to admit the existence of chambers closed by these membranes. This image is produced with all sections, even with those of large species, but that aspect disappears when the section is sufficiently thin and when it is examined with high-powers. It is then seen that the black lines, representing the membranes, are discontinuous and interrupted by bright spots representing openings. It is understood that to study these details, the thinness of the section should depend upon the fineness of the markings to be resolved. The greater part of the fine work of M. Flögel has been again put in question by the observations of Mr. Müller, who has shown that the sections obtained by that savant were too thick and that the closed chambers which he described should have been open, since they became filled by immersion in balsam. Müller, however, only admits their opening on the exterior side.

"The impressions in collodion do not seem to have given the authors who have employed that process the results expected. On the other hand, the submersion of valves has likewise furnished facts which fail of concordance.

"The figures obtained by photography are, as the theory of Prof. Abbe shows, the reproduction of illusory images, due to diffraction fringes, at least for diatoms of which the markings are so arranged as to give place to phenomena of this kind. The examination of valves by reflected light, as proposed by Mr. Deby, proves nothing more than the examination by transmitted light, for it is not possible to eliminate by this process, the causes of error due to phenomena of diffraction.

* *Bull. de la Soc. Belge de Microscopie.*

"To show the difficulty of these researches, it will suffice to remember that the portions much less delicate, such as the connectives, the raphe and the nodules, give rise to interpretations very diverse."

We have not given the whole of M. Prinz's remarks, but in a later number we shall print a *résumé* of some very interesting later results, obtained by M. Prinz and Dr. Van Ermengem working in conjunction upon this subject, to which the above will be an introduction.

Evenings with the Microscope.

III.

There are so many subjects that would afford ample pleasure and instruction for an evening, that it is difficult to choose one to write about. A superabundance of material is frequently quite as embarrassing as a dearth of it. In beginning this article we have not yet decided upon any subject, but perhaps we will soon come to one. People are often heard to make comparisons between natural objects, calling one more beautiful or more interesting than another. Now, it is very true that the wing-case of a diamond beetle, mounted in balsam and carefully illuminated with a bull's-eye lens, is a more strikingly beautiful object than many other things we see under the microscope. But it may be doubted whether the golden sparkle and brilliant green of the scales possesses any greater charm to the naturalist than does many a more common object. Not that the naturalist is less appreciative of the beauty which all may see, but because he has a deeper knowledge of the structure and adaptation of the things he studies than any superficial glance can give, and hence a better appreciation of the object as a whole. Therefore the student of nature would say; every natural object is beautiful, and though some

may be more pleasing to the eye than others, such beauty is only superficial, and the same kind of influences that have in one case produced bright and rich colors, in another have given us subdued and common ones. Hence it is, that so far from disregarding the colors of natural objects, the naturalist attaches even greater importance to them than the casual observer, who sees only that they are bright and pleasing; never thinking of their greater significance in the living world.

As microscopists and students of nature, is not the pleasure and satisfaction we get from the examination of objects of whatever kind, enhanced by the knowledge that all the different forms of minute shells and spicules, diatoms, desmids and infusoria, indeed from the lowest rhizopods and protophytes, all through the range of plant and animal life, every structure is the result of one invariable natural law, — the law of adaptation to environment? This is only another way of expressing the tendency manifested throughout the living world to improvement and higher development.

At last we have found a subject which will serve for an evening's work. It is the mounting of polycystina. When the surface of the sea is undisturbed by the wind, so that there is scarcely a breeze to move the vessel forward, if a fine surface-net were thrown overboard and drawn slowly through the water in mid ocean, it is probable that a vast number of minute floating protozoa would be collected. Among these the radiolaria, to which the polycystina belong, would be numerous; but besides the polycystina there would be many beautiful, extremely delicate forms, which we never find in the fossil deposits of Barbadces, because they are too fragile to be preserved as fossils. Some polycystina live upon or near the surface, others at the bottom, and their remains are found in great abundance at depths of four or five miles from the surface. The specimens we have

for mounting, however, mostly come from two sources, the Barbadoes and the Nicobar Islands, where the fossils occur in great abundance.

To separate the perfect forms from the mass of hard rock in which they are found will be good work for one evening at least, when the mounting may be deferred to another time. The rock is first disintegrated by boiling in water containing some carbonate of soda, and the fine powder is then boiled with dilute nitric acid. After thorough washing the powder is dried, and may then be sifted through sieves of fine muslin, or bolting cloth, which may be conveniently made by taking out the bottom and top of a good-sized pill-box, and stretching the cloth over it, forcing the ring of the cover on to hold the cloth. After sifting, the forms can be picked out readily under a hand-lens, or the sifted portions most rich in good specimens, can be mounted as they are.

Polycystina may be mounted in several ways, and however prepared they make good slides for exhibition purposes. If any readers are especially desirous of obtaining some of the Barbadoes material for cleaning, the editor can supply a small quantity to those who will send a stamped and addressed envelope.

PREPARING POLYCYSTINA FOR MOUNTING. — The ordinary appearance of polycystina is clear and glassy. They may be mounted in this condition, but for opaque objects they are usually subjected to a strong heat for a few seconds, which gives them a beautiful porcellaneous appearance. The best way of heating them is on platinum foil. But as this is expensive and not usually at hand, any convenient means may be employed. A thin strip of metal, or a piece of charcoal may be used, the flame being directed by means of a blow-pipe.

MOUNTING IN BALSAM. — Either the glassy or the heated specimens may be used. In the early days of

the New York Microscopical Society we remember Mr. D. B. Scott used to mount polycystina in balsam, to illustrate his method before the members, and it is his method we will now describe.

The forms are placed upon a slide, with a considerable quantity of balsam in benzole or chloroform, and the cover-glass laid over them. The balsam is then heated until the benzole or chloroform boils very briskly, after which the slide cools, and the work is done. The object of boiling is to drive out air, and to distribute the shells evenly. By using the dissolved balsam the slide can be finished in a few minutes, for when the solvent is driven off only hard balsam remains.

MOUNTING DRY. — The finest slides of polycystina are those prepared with selected specimens, perfect in form and arranged in groups. It is not difficult or tedious to make a good group of polycystina. It can be done without any mechanical aid, although many amateurs use mechanical fingers of various degrees of complexity. Certainly there can be no more perfect and beautiful slides of arranged objects than those mounted by Mr. Arthur C. Cole, and they are all done, even the finest groups of arranged diatoms, with the free hand.

The cell for mounting may be prepared in any convenient way. In the article by Mr. E. Ward all necessary information about cells will be found. A small, black, opaque central spot can be put on with asphalt, upon which the specimens may be mounted. This is better than to make the cell entirely opaque, as it enables the lieberkuhn to be used in illumination, if desired. The specimens are fixed in place by gum-arabic, a drop of a weak solution being dried upon the background, and moistened by breathing upon it when the specimens are placed in position. This causes them to stick firmly, and when thoroughly dry there is no danger of detaching them by any ordinary handling.

Wenham's Radial Microscope.

Messrs. Ross & Co. have made a number of stands according to the designs of Mr. Wenham, which they have designated by the name heading this article. The radial microscope is the most complete and perfect stand ever devised. It seems to meet every demand that the microscopist can ever make of a stand.

An examination of the cut (fig. 24) will give a good idea of the plan of construction. It will be observed that the object is

a centre about which every moving part turns. Placing the mirror on the base, directly beneath the centre of the stage, in a place provided for it, the light can be thrown upon the object and will remain upon it while the stage, or the body-tube, are inclined to either side. The following is clipped from the catalogue of the manufacturers, and will serve to bring the principal features of this stand into notice :—

"This Microscope has been devised for the special purpose of obtaining the maximum range of oblique illumination in all directions, which is attained by causing all the movements of inclination and rotation to radiate from the object as a common centre. Seven radial motions are here combined :—

1. The inclination of the whole instrument (except the base) from the perpendicular to the horizontal, by means of a sector sliding between jaws attached to the upper base-plate.

2. The lateral inclination of the limb to either side, carrying with it the tail-piece, etc., or of the limb and stage only, the tail-piece being clamped

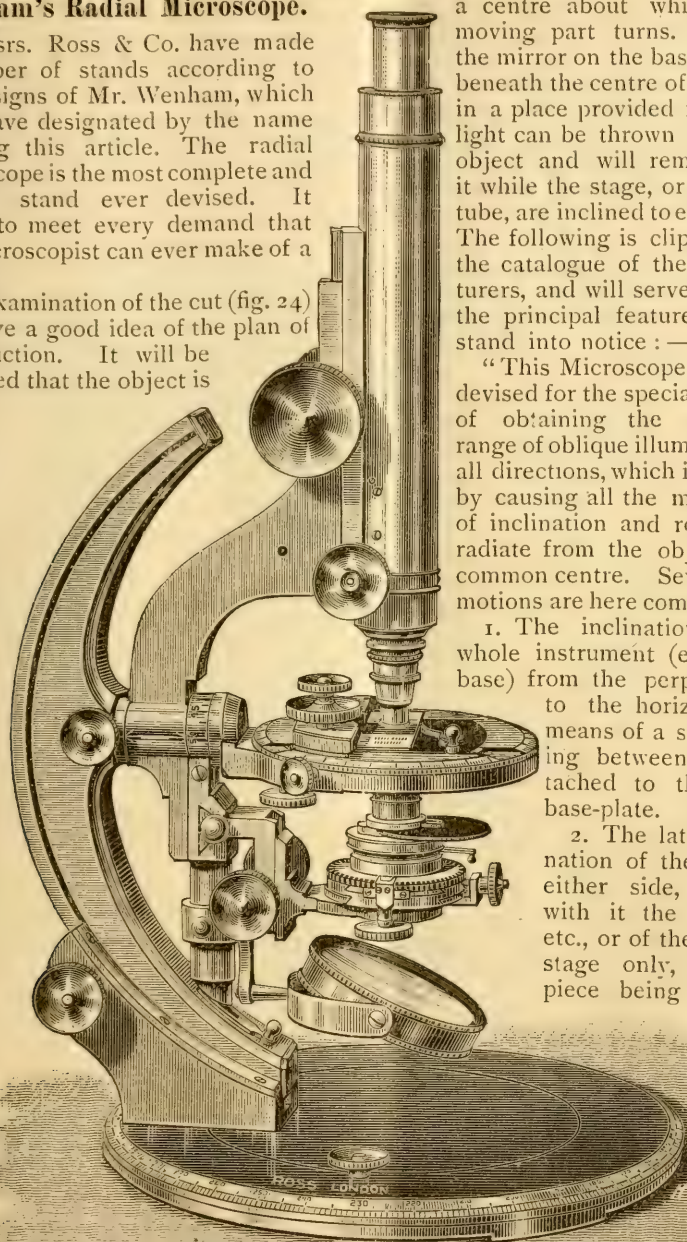


FIG. 24.—WENHAM'S RADIAL MICROSCOPE.

to the sector. With the sector clamped at the usual angle, this latter arrangement furnishes very ready and practical means of varying the illumination in altitude from 0° to nearly 90° , either direct from the mirror or combined with a low-power condenser, the hemispherical or Wenham's semi-disc illuminator.

3. The rotation of the whole instrument on the lower base-plate on an axis which is the prolongation of the optic axis when the instrument is vertical, as shown in the figure.

4. The swinging of the tail-piece suspended on an axis, the centre line of which passes through the object on the stage, cutting the optic axis at right angles.

5. The complete rotation of the mechanical stage upon the optic axis, secured by the milled-heads for the rectangular motions being placed on a vertical axis on the stage and acting entirely within the circumference. This stage can be easily removed, and may be replaced by a glass or other stage.

6. The complete rotation of the mechanical sub-stage upon the optic axis.

7. The partial rotation of the lamp, etc., in azimuth, upon an arm pivoted in the centre of the lower base-plate.

The Coarse Adjustment is on the Jackson principal, and is worked by diagonal rack and spiral pinion.

An entirely new construction of fine adjustment is applied to this microscope, consisting of a V-slide acted upon by two "snail"-cams, between the edges of which revolves a steel roller, forming the axis of and actuated by a large milled-head passing longitudinally through the slide of the coarse adjustment, and projecting slightly on either side in a convenient position for work. The V-slide is fitted within the body-tube, carries at its lower end the nose-piece, and is pressed downward by a spiral spring,

against which it is moved by the revolution of the cams. By this system an extremely sensitive and direct focussing is obtained, which will compare favorably with any hitherto applied to the Jackson model of microscope."

A thin, diatom-stage is provided,

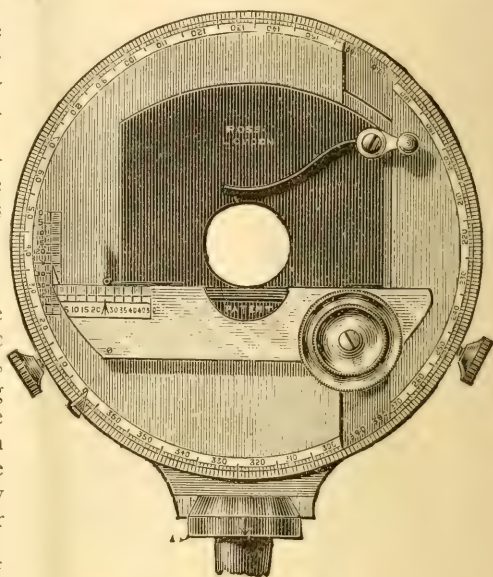


FIG. 25.

represented in fig. 25, with mechanical rectangular motions on one axis, entire rotation by milled-head beneath

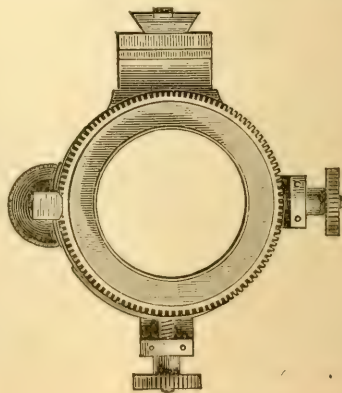


FIG. 26.

(easily thrown out of gear when a quicker motion by hand is required), centering screws to secure exact rotation round the optic axis, marginal graduations, and finders engraved in convenient positions. A simple and effective plan has been adopted for applying an iris-diaphragm, or hemispherical illuminator, beneath this stage, where they are held by a small projecting peg and a spring latchet.

Two forms of sub-stage are adapted for this stand, the more elaborate of which is shown in fig. 26.

This sub-stage has rectangular motions for centering, actuated by two milled-heads. It also makes complete rotation, by means of a circular rack and pinion, for varying the illumination, measuring angles of crystals, polarization, etc. If a simpler form is desired, a non-rotating sub-stage can be supplied instead, with a three-bearing, centering arrangement.

Notes from Abroad.

Spending a short time in Manchester we were fortunate in discovering, quite by accident, attracted by the display of microscopes and apparatus in the shop-window, Mr. E. Ward, who is well known to most of our readers as a preparer of series of unmounted objects for microscopists. Entering, for a few moments' chat with Mr. Ward, we found him doing a thriving business in selling microscopes, material, and slides of his own mounting. After looking over a large collection of slides, and selecting a few choice ones for ourselves, Mr. Ward proposed that we should go out and make some collections. This was an opportunity not to be neglected; so, in a few moments we were on the tram-car bound for Withington, a suburb of Manchester. The road passes through the finest residence portion of Manchester. On either side, seated as we were on top of the car, we could look over high hedges or stone walls into the private

grounds of the wealthy. The well-kept shaded lawns and winding carriage ways, with here and there a porter's lodge at the gateway, reminded us of descriptions of English homesteads we had read in books. The hawthorn was in blossom, white or tinged with pink, and the laburnum trees were loaded with golden chains of flowers.

Finally we alighted and began our tramp for the open country. One really needs a guide to go collecting in England, for it is so difficult to find the right localities. Mr. Ward is an enthusiastic and experienced collector. He led the way to a place known by the curious name Gatley Carrs, where we found a path along a railroad. By turning over the leaves of the goutweed, and looking at the under surface, we found some good specimens of the fungus *Puccinia ægopodia*, which looked like black shining spots on the leaf. This was found in considerable abundance. Passing on we came to a turnstile, through which we passed into a path along a brook. This we followed a considerable distance, picking a few blue bells and buttercups to send home, but finding very little to collect. In the brook we found some beautiful *Draparnaldia*, in abundance, and some *Vaucheria*, but not much else of value. Still following the path which led away from the brookside, along green and cultivated fields, we at last reached a village, where we entered a public house to wait for the stage to take us back.

Mr. Ward does a large business in mounting slides for the trade, and in this work he has become very expert. We are pleased to learn, therefore, that his experience has fully confirmed what we have so frequently stated in these columns, that shellac makes the best cement for general use. Mr. Ward, however, has succeeded in making a mixture which he calls brown cement, shellac being the principal constituent. The brown cement is now to be obtained from the dealers, and has met with a ready sale.

Attending a meeting of the Quekett Club, on the evening of June 8th, we had an opportunity to observe how the gossip meetings were conducted. They are entirely informal. Members, as they arrive, immediately set up their microscopes, and exhibit whatever they may deem of interest. Each member is provided with a slip of paper with blanks to be filled up as follows:

QUEKETT MICROSCOPICAL CLUB.

Meeting, Friday, ... 188

Object.....

Points of interest.....

Exhibited by.....

This ticket is to be given to the Secretary at the close of the meeting.

Two blank lines are reserved for the object, and three for "points of interest."

At the meeting Mr. W. Irwin Curties showed some beautifully mounted isolated annular cells from the stem of *Opuntia cylindrica*. Mr. G. Mainland showed a slide of *Plumularia* killed with tannic acid. The bodies of the animals were extended from the cells, and while showing the nature of the animal reasonably well, we believe quite as good preparations can be made in the old way by killing the animals with alcohol. Still, the tannic acid process is not yet perfected, and it seems not unlikely that for such specimens as hydroids and zoophytes the acid had better be dissolved in alcohol instead of glycerin. This specimen was shown with the chromatoscope, which will be fully described at a future time. Mr. H. R. Gregory showed *chatophora elegans*, the beautiful branching alga, which grows within a gelatinous ball, with dark field illumination, which made it an unusually beautiful object. One thing will be observed by persons visiting England as microscopists, which is the care taken to show objects in the most striking and effective manner. All kinds of illuminating apparatus are employed, and applied with skill, as

though each object had been made a subject of study for the purpose. This is done to some extent in our own country, but not so much as is to be desired.

Much interest has been aroused in the fresh-water medusa, which is quite abundant now, so we append an abstract of Mr. Bolton's description of this delicate organism, *Limnocodium Sowerbii*:—"Discovered in the Victoria Regia Tank, of the Royal Botanic Society, Regents Park, London, on June 9th, 1880. The Generic name (*Limnocodium*) pond bell, very happily describes the general form of the animal, which much resembles a small, shallow, nearly hemispherical bell, of the most delicate structure, transparent almost as glass, the tentacles of a beautiful opalescent white, and, as seen floating in the water, resembling the ordinary Marine Jelly-Fish, but from which, however, it differs in many particulars. One of the peculiar features is, that the tentacles are extended upwards when the animal is floating, instead of hanging from the bell, as in most other members of the group. It was exceedingly interesting to watch their habits, swimming and floating about at will in all directions, their activity being stimulated by the warmth of the water, so that, by counting the pulsations, the temperature of the water might be ascertained. It is exceedingly difficult to trace the introduction of this animal into the tank in the Regent's Park, since no plants have been recently added to the lily-house, and the water is run off every year. Probably a few specimens were last year, or the year before, present in the tank, and have only this year multiplied in sufficient abundance to attract attention. Clearly the Medusa is a tropical species, since it flourishes in water of this high temperature (90° F.). The diameter of the disc does not exceed $\frac{1}{2}$ inch. Described by Professor E. Ray Lankester, in Quarterly Journal of Microscopical Science, July, 1880.

Passing along to where the culture of oysters is illustrated and explained, we observed, in several places, microscopes arranged to show the young oysters or "spat" as it is called, and, as it has been a matter never fully explained to us how the young oysters for mounting were obtained, we took occasion to inquire of one gentleman who had some "spat" in a bottle estimated to contain 1,740,000 young, all from a single oyster. These were obtained by placing the oyster in a vessel of salt water until the spat was discharged naturally, after which it was collected and bottled. There is much more in the exhibition worthy of notice, but we must defer more extended remarks until a future time.

Mounts and Mounting.

[The following article is an abstract of two papers read before the Manchester Science Association and the Manchester Microscopical Society, by Mr. E. Ward, F. R. M. S. Mr. Ward has had great experience in mounting, and he does a large trade in microscopical slides of his own preparing. The articles are published by him in a small pamphlet, and entitled respectively, "Microscopical Mounts and Mounting" and "Micro-crystallization." — ED.]

In the early days of the microscope, mounting must have been a very different matter from what it is now, and as I use (and sometimes break) circle after circle of covering glass, I like to think that it was before my time that mica or talc was used for the same purpose.

I believe that one of the earliest methods of so-called "permanent mounting" was by placing the objects (thin enough to be examined by transmitted light, without preparation) between two thicknesses of mica, and putting these between two card-board slips having a hole punched through them. A little later, so far as I can learn, the plan was adopted of placing

the two mica flakes, enclosing objects prepared in the same simple manner, in slips of wood, bone, or ivory, each of these slips sometimes containing several objects.

I wish that I could follow, chronologically, the many improvements made in microscopical mounts — one of the greatest was the introduction of Canada Balsam.

It had long been felt to be one of the greatest needs in the preparation of objects, that some medium should be discovered in which the more opaque ones could be well displayed. That such a medium had been found was shown at a meeting of Micromaniacs, held at the residence of one of their members, where, on an evening, some forty years ago, some objects were placed under the microscope, which, from the clearness and distinctness of the view, caused great delight to the beholders, who naturally wanted to learn how these (to them) most magnificent results were obtained.

The disappointment must have been intense when they were told that this was a profound secret, known only to three persons, each one of whom was pledged to the others not to divulge it; but a gentleman present, while holding up one of the slides for examination, pressed the glasses together between his fingers, and when warned of the danger of thus handling newly-mounted specimens, changed its position and held it by its opposite edges. But he had already pressed out a very small portion of the mounting medium, which, smearing his fingers, disclosed, by its now well-known scent, the secret of mounting in Canada Balsam, and we enthusiasts may imagine the delight of this worthy worker, when, without any underhand action, he had thus "smelt" his way to results similar to those so much admired. But we, most of us, have, early in our work, learned that there is a difference, and a vast one, between knowing that an object is mounted in Canada Balsam and being ourselves able to mount in this medium; and

the description given by one of these gentlemen of his endeavor to imitate what he had seen, is applicable, in a greater or less degree, to all those who now commence practising the "sticky art":—

On the evening appointed we set to work, being, with careful forethought on the part of the mistress of the house, provided with an old iron tea-tray. The Canada Balsam was produced, and an ample supply poured upon one of the usual sized glass slips. We then adjusted upon the convex side of this fluid the wing of a butterfly gently pressing it into the fluid to expel the air from beneath. A further supply of Balsam was then poured upon the upper surface of the object until it was completely immersed in the fluid; a second slip was then laid over the first, and the two slips were gently, but firmly, pressed together, and secured by thread bands; and so we proceeded with six or eight specimens, but by this time we were fairly brought to a standstill, our fingers being Canada Balsamed up to the knuckles, and our hands when we attempted to separate the fingers, being like the feet of a web-footed animal; so we were compelled to strike work, and adjourned to regions below, where by a not sparing use of turpentine, soap, and hot water, we cleaned our objects and restored our hands to a comparatively clean condition. We were, however, amply rewarded for all by finding upon examination that *our* objects were quite equal to those that had been shown to us.

These gentlemen then quickly spread among their fellows the knowledge of the new mode, and it at once became the favorite method of mounting. In later years the number of workers has increased. New media and new modes are constantly being recommended, and the united skill of an army of workers has made mounting a pleasure, and the examination of mounted specimens a constant delight; whilst neatness and beauty of finish are now aimed at as well as the successful display of the object.

The easiest objects that a learner can begin with are, I think, those that are merely mounted dry in a shallow and not opaque cell, such as wings of

butterflies, and the scales removed from the wings, delicate pollen grains, fern spores, scales, cuticles, etc.

In commencing work it will be found advisable to prepare a number of slides by putting them on a turn-table, and with a brush charged with brown cement, or some similar viscid preparation (the solvent of which should be spirit), run circles upon a number of slides, and put on one side to dry; this, with brown cement, will to a certain extent quickly take place, when, if the cell is not deep enough, another, and yet other layers may be added. Now, having a number of these cell slides ready, we wish to mount a slide of scales of butterfly, which can easily be done. Cut a bit of ordinary printing paper, about one inch by half inch, fold it in the middle, and then, placing in the fold a small piece of the wing, press steadily and with a slight sliding motion, when the scales "from both sides" will be, as it were, pulled from the wing and remain upon the paper. If now the paper be divided, and a clean cover-glass of the chosen size be taken, it will be found that by breathing upon the cover, and then at once putting down upon it first one and then the other of the papers, scale side to the glass, the scales will adhere to the glass cover, and then by gently warming over a spirit lamp one of the slips prepared as described, the ring of cement will be softened, and the cover-glass with scales may be pressed closely to it, and when cold all will be found firmly fixed.

If it is desired to mount a small piece of the wing, see that the cell is sufficiently deep, and then, placing the wing in the centre of the cell, by warming the cover-glass and at once putting it down on the cement ring it will attach itself firmly, and may be thus put on one side.

Some of the fern scales and stellate hairs from plants may be arranged in the centre of one of these cells, and are often fixed firmly enough by the pressure of the warmed cover upon

the cement ring, but in these cases it is advisable to have a shallow cell. Pollen-grains, having been allowed to dry, and a slide with cell having been prepared by being breathed upon, the pollen-grains may be dusted upon the slide, when the warmed cover-glass will in this case also securely seal up the object. For pure diatom gatherings or deposits that are desired dry, it is only necessary, after sufficient cleaning and washing, to put a drop of the fluid containing them upon a cover-glass, and allowing this to dry, not by heat, but quite spontaneously, by warming the slide and cell as described for butterfly scales — the cover may be pressed down and securely fixed.

Canada balsam, with its sticky abominations, has now largely given place to balsam and benzole, balsam and chloroform, or damar, each of which medium has advantages over the other for certain objects; but my choice for general work is balsam and benzole, which I have used for years, and for a great many descriptions of work. As an illustration of balsam mounting, or rather mounting in balsam and benzole, we will take some objects from the animal kingdom — say parasites. It will in most cases be advisable to put them in liquor potassi for a short time. When they have been softened or sufficiently reduced in color, they must be well washed in water, and if they are brushed under water with a stiff camel-hair pencil, the legs will frequently be found placed right for mounting.

The last washing water having been poured off, and methylated spirit added, let them remain in this for a few hours, and then the spirit be renewed. After the lapse of a few hours more, pour off the spirit and add oil of cloves or cajeput. The latter is quite equal to and much cheaper than the clove oil. From this the object may be placed upon a clean slide, and any surrounding oil should be absorbed by blotting or filter paper; a drop of balsam and benzole being

placed upon it, the slide may be left for a few seconds, and then a warmed cover-glass put down, a clip placed upon it, and the operation of mounting is so far complete. The slide now requires placing in a warm place for a few days before the later finishing touches can be applied to it.

If it be Polycystina, Foraminifera, Sponge or Gorgonia Spicules, or any such object, that it is wished to mount, a thin smear of gum should be placed on one side of the centre of the slip, when, if the thumb be drawn firmly over the slide, a very thin, almost invisible film will remain, which must be allowed to dry. If then a small heap of the dry material be put on the centre of the smear, and the slide, while held in the fingers at one end, be gently tapped on the other by the foreceps, or anything hard which happens to be handy, the material will be seen to spread itself over the gummed surface, and its disposal may, with a little practice, be greatly controlled. The slide now requires breathing upon, and when again dry, a drop of the balsam and benzole must be put over the object, the cover-glass warmed, put down, and held with a wire clip. The slide should be gently heated over a spirit-lamp until the medium just begins to boil, when it must be removed quickly to a moderately cool spot. This boiling has the effect of driving out the air from in or around an object; and should any bubbles appear about the slide, they will almost invariably disappear when the slide is left in a warm place.

In mounting starches in damar, for polariscope, a similar plan may be adopted to spread the material, but in this case no gum is required, the breath upon the slide being enough to hold the granules as they move over the slide. When the breath has evaporated it is not at once advisable to at once drop on the damar, but first placing over the starch a clean cover-glass, put at each edge of the cover, but not exactly opposite, a drop of damar, which running under the cover

from each side, will imprison the object. If the damar wave does not appear to travel freely, a little movement with a needle at the edge not touched by the medium, will accomplish the purpose, and the slide may then be put away to dry; but in the case of starches it is not well to put them into a very warm place.

The same plan may be adopted in the case of pollens, fern spores, etc., and the two waves of damar will do what is otherwise very difficult, keep such delicate objects where we like them to be, in the centre of the slide.

At this place I may just point out, that if good mounts of fungus spores, such as the *Puccinia*, are wanted, the spot of fungus should be removed from the supporting leaf by means of a very sharp-pointed scalpel, and then the slip being breathed upon, the fungus will adhere to the glass; but in some few cases, as in *Xenodochus*, the spores are so dense, that it is not well to at once add damar; but in such a case a drop of benzole, placed by means of a bit of rolled paper or match, by the side of the spores, will quickly penetrate them; when this has nearly evaporated, a drop of damar may be put direct upon the spores, and I would then suggest that the cover-glass be not put down for half an hour, and it will be found that when warmed and put down it will not so easily move the objects, as it would do if this plan was not followed.

The next description of mounting to which I would refer is one which, to a beginner, is frequently a stumbling-block. I mean glycerine jelly, which is an exceedingly convenient method to adopt when the object would be rendered too transparent in balsam or damar, or when it is undesirable to dry it at all.

In the preparation of the many things from the vegetable kingdom, as mosses, algæ, cuticles, sections, etc., and from the animal kingdom, as many eyes and wings of insects, gastric teeth, palates of the mollusca, it is only necessary, if they are suffi-

ciently clean and not too dark in color, to put them for a few hours into a mixture of methylated spirit, glycerine, and water, about equal parts of each, although exactness is not necessary, as the mixture may be varied to suit circumstances.

When they are taken from this mixture, they must be placed upon the centre of the slide, and the surplus liquid absorbed by blotting-paper. Either of two plans may now be followed with regard to the jelly—it may be liquified by placing the bottle in hot water, and then dropping the liquid jelly upon the slide, or, as I frequently prefer, a small piece may be cut from the bottle and put upon the object and the slide gently warmed, when the jelly will diffuse itself through the object, and will be found exceptionally free from the enemy, “air-bubbles;” but should there be air bubbles, or not, it is of great value to boil the jelly and object upon the slide, but care must be used or the mount may be ruined. Should the boiling be decided upon, the clip should be used, and the slide held by the clip directly over, but not too close to the flame of a spirit lamp; it will at first begin to bubble from the centre outwards, and if the slide be now carefully watched, a very perceptible crack may be seen and heard, at this moment, and without delay, the slide must be withdrawn from the heat, and placed upon a cold surface (in my work a block of marble), when the jelly will rapidly contract and the air bubbles will be excluded.

The jelly mounts are easily cleaned from superfluous jelly, by brushing with a soft tooth brush under a running tap, and the surface of the slide being allowed to dry spontaneously, it will be found that it is free from glycerine smears, which interfere much with the after-process of finishing.

MICRO-CRYSTALLIZATION.

Not being a student of crystallization as a science, I have not to discuss on the classification or angles

of crystals, but to describe, in as simple a manner as possible, how I have produced and how you may probably produce interesting, beautiful, and valuable microscopical slides of some of these wonderful forms.

In describing the mode of preparation of some of the micro-crystals, those which are most readily prepared have been selected, — one of the easiest being tartaric acid; this, like many others of the common objects of the microscope, is very beautiful, and is thus prepared: —

Make a strong solution in water of the acid crystals, and having warmed a slide, drop on the centre a little of the solution and evaporate by gentle heat, that is by holding the slide some four or five inches above the flame of the spirit lamp. If only a small drop of the solution has been used, the crystals will be thin, and will require a selenite to bring out their utmost beauty; but if the drop of solution is heaped up, as it were, on the slide, the crystallization will be stronger and will not need the selenite, but as the polarizer is rotated, the color will be well shown.

Immediately following this, may be mentioned gallic acid, of which a moderately strong solution is to be made in methylated spirit. Drop a little of this solution in the centre of the cold slide and allow to evaporate very slowly; if, however, smaller crystals are desired, as soon as the slightest appearance of crystallization is visible, slightly, very slightly, warm the slide. A third and different form of crystal is obtained by adding together saturated solutions of the acid, both in water and methylated spirits; then placing a little of the mixture on the centre of the warm slide, and as soon as the crystals commence to form, pricking the centre with a cold needle.

The preparation of the slides from these two acids separately, naturally at this point leads me to notice a form of crystal obtainable by a mixture of the two as follows: —

Make a strong solution of each in

methylated spirits, and then, mixing both together, place a drop upon a cold slide, gently warm until opal, oyster shell-like crystals begin to appear; instantly then remove from the warmth, and generally the appearance of the slide is improved if now it is cooled rapidly by placing it upon a cold surface; but this is a matter requiring more attention and experiment than has yet been given to it, and though I cannot always depend upon getting this precise form, when obtained, they are very interesting, showing a combination of the broad crystallization of the tartaric, and the needle-like crystals of the gallic acid. This combination when produced needed a name, and upon recommendation of some chemical friends, it was designated gallo-tartaric acid.

Pyrogallic acid, a substance at the present time well-known to photographers and photo-micrographers, next claims our attention, and will yield at least two good forms to the student of crystallography. By making a cold saturated solution of this acid in water and placing a drop upon the slide, it will very quickly cover the spot with long needle-shaped crystals; but if a very minute shower of some insoluble foreign substance be allowed to fall upon the solution when on the slide, the effect is grand, — each minute speck forming a nucleus around which the needle-shaped crystals gather, forming, if examined with a selenite slide, so resplendent an object that no words of mine can adequately describe it.

Hippuric acid will also be found worthy of all the attention that can be given to it, and upon experiment would probably yield many varied results. I will mention two I have produced, known respectively as circular and floral crystals.

Circular, or as they are frequently called, wheel crystals, may be obtained by making a strong solution in pure alcohol; in this case methylated spirit not answering sufficiently well. Drop on a warm slide a little of this solu-

tion and immediately hold over a spirit lamp, removing the slide from warmth directly the crystals begin to form; but should the crystallization stop, it can be caused to recommence by again warming.

Floral crystals may be obtained from the same solution, but it must be dropped upon a cold slide; and if the slide is gently waved about to evaporate the alcohol, the floral crystals will form; and the suggestion may be offered, though I have never put it to experiment, that if a rotary movement is given to the slide, the crystals, as they form, will be a combination, possibly taking the character of circular florets.

As a conclusion to my selection of acid crystallizations, your attention must be directed for a moment to citric acid, which, although a most difficult form to produce, is so strikingly beautiful that it deserves the expenditure of all necessary time and trouble. The most successful plan with this acid is to make a very strong solution in cold water, place a drop on the centre of slide, and at once pour off all surplus fluid, leaving as it were only a film. Put the slide on one side for a short time, say half an hour, then warm very gently and but slightly, and allow to cool very gradually; repeat these operations until the rosette crystals are formed. This may occur at the first cooling, or it may take several applications; sometimes, in fact, it is found impossible to cause them to form at all, and as it is noticable that when formed, too much heat will cause them to disappear, it may be that too great a warmth in one of the warmings is the cause of their non-appearance.

All the crystals yet described, except the last, should be mounted in pure Canada balsam; but this last preparation is best mounted in a solution of evaporated balsam in benzole.

Passing now from the acids to the salts of some of the metals, I would direct your attention to potassium and sodium, which yield with little trouble

many good forms of micro-crystallization. These salts include the arseniate, carbonate, chromate, and bichromate, bitartrate, chlorate, iodide, nitrate, oxalate, ferricyanide, ferrocyanide, sulphate, urate, etc. Of these I need only mention one or two which have been brought more particularly under my own observation and preparation.

As in the acids, I will refer first to one that offers but little difficulty to the amateur mounter—the chlorate of potash. The most typical form of this salt is that in which the crystals are each separate and distinct. To obtain these it is necessary to make a strong solution in hot water, and to place a little of this solution upon a slide (previously breathing upon the slide, which causes the liquor to spread evenly). The slide must then be placed on one side, that the crystallization may proceed gradually, and if the solution has been made from pure chlorate, the crystals will be large and fine.

For the imperfect, or as they are generally known, the dendritic crystals, place a little of the same solution upon a slip and heat over a spirit lamp. Immediately the crystals begin to form at any point, at once tilt the slide away from that point, so that all surplus liquor may run off, then continue the crystallization by gentle warmth.

Somewhat similar in outward appearance to separate crystals of potassium chlorate, I may here mention those of sodium nitrate, which are however, obtained in a slightly different manner, and offer a little more difficulty in the production.

A strong, nearly saturated solution, must be prepared in cold water, and a drop put upon a cold slide. In a very short time crystals will reveal themselves as small points rising from the surface of the liquor. At once all surplus mother liquor must be poured away, and the slide must be gently warmed over a spirit-lamp; and at the same moment it will frequently be found advantageous to blow upon the

surface of the slide. I cannot offer any reason for this, why it does good, but it is often to be noticed that these little dodges improve materially the character of a slide.

Potassium ferrocyanide, or prussiate of potash, can be made to assume very beautiful dendritic forms, but the plan found to answer best with this, is to make a hot, nearly saturated, solution in water, and then placing a drop of the solution on a warm slide, jerk off, with a rapid movement of the hand all surplus liquor. The jerk, which leaves but a thin film upon the slide, also very quickly causes the cooling of the slide, and the instant crystallization of the salt. It may be suggested that the same process may be successfully employed with many other salts. The potassium chlorate is said to be a success by this method, as also is barium chloride.

Biborate of soda, or borax, is not a difficult slide to produce, but when formed and mounted safely in balsam and benzole, it must be allowed to dry naturally, as the application of even very moderate heat will cause the utter destruction of every crystal. This I learned by sad experience; for some time since, having mounted several dozens of this slide, I at once placed them above my hob to harden the balsam, and was annoyed to find all spoilt in one afternoon.

If this salt is allowed to crystallize gradually, from a cold saturated solution in water, the crystals will be large; but if a nearly saturated solution be made in pure alcohol, it will crystallize almost immediately it is placed upon the cold slide, but the crystals will be much smaller than those from the aqueous solution.

Turning now for a short time to the salts of ammonium, I will direct your attention to the ammonium chloride, known commercially as sal ammoniac. This requires only a moderately weak solution in cold water, of which a drop is to be placed upon the slide and then drained off, leaving but little upon the surface. This must then be gently

warmed by holding over a spirit lamp, at the same time cooling from above by blowing upon the slide as described before.

Ammonium bitartrate differs much from the last described both in appearance and in mode of production. It requires a very strong solution in hot water, of which solution a drop should be placed upon a warm slide, and if allowed to cool gradually, small and distinct crystals will be formed, which when quite dry, which is absolutely necessary, are best mounted in balsam and benzole.

Ammonium oxalate also forms a beautiful object, if an aqueous solution is evaporated upon a slide, and mounted in pure balsam; but more beautiful than this, is the ammonium oxalurate, which is deservedly popular.

Of this latter salt make a hot saturated solution in water; place a little upon a cold slip and warm very gently, when circles composed of numerous needle-shaped crystals will commence at the edge of the drop of fluid and extend gradually towards the centre; but the beauty of this microcrystal is increased if a fine point of wood is held in the centre of the fluid, when the needle-shaped crystals will radiate from this artificial centre.

If instead of this hot saturated solution we take a cold but not quite saturated solution in water, and evaporated still more slowly upon a cold slide, the crystals will assume more distinctly the circular or wheel character previously described; and they are so delicate that when mounted in pure balsam, they become almost undistinguishable unless examined by polarized light.

Before leaving this group I must refer to ammonium purpurate, frequently known as murexide, a salt which is obtainable by the decomposition of uric acid, and is also found among urinary crystals in certain abnormal conditions of the secretive organs. A solution of this salt in water, upon evaporation, deposits the crystals in

short and flattened four-sided prisms which show well by polarized light, and possess the analytic character referred to later.

Besides the salts of ammonia described, may be enumerated the borate, muriate, phosphate, sulphate, urate, and platino-cyanide; with these I have had but little experience. I may say, however, that of themselves, and in combination with other things, you will find them worthy objects of study or amusement.

Turning now to magnesium, we find that at present there are not so large a number of its salts that are recognized as micro-crystals; but I must not omit from these the well-known Epsom salts, or magnesium sulphate, which will produce, according to the mode of crystallization, very varying results. The most typical and one readily produced, is obtained from a saturated, or nearly saturated, aqueous solution, which, if allowed to crystallize very slowly on a slide, will result in much larger crystals than if the slide, with a drop of the solution, is very gently warmed. These crystals, if mounted in pure balsam, will, with selenite, form a brilliant slide.

Ammonio phosphate of magnesia, or as it is frequently called, triple phosphate, is like the murexide referred to before, a production from urine, and occurs in many different forms, of which the one known as the prismatic form is the most frequent. This salt is not a commercial product, but it is said that the crystals may be obtained by allowing urine to decompose, or by diluting the secretion with water and adding in small quantities dilute ammonia solution.

One other salt of magnesia, the platino-cyanide, must be referred to, and as well as being one of the most beautiful, it is, of the platino-cyanides the most easy to prepare. Most of them, it will be found upon experiment, offer almost insuperable obstacles to any but a scientific chemist.

To obtain these micro-crystallizations, make a strong, but not quite

saturated solution in pure alcohol, and place a drop on a cold slide, which should be covered with a shade of some kind to prevent the too rapid evaporation of the alcohol. A watch glass will answer this purpose, which allows time for the gradual building up of the desired crystal, but if, as frequently happens, it is found that good crystals have not been produced, drop upon the same spot a little more of the solution: this will re-dissolve the crystals already formed. Again cover with a shade, and in due time new and probably better crystals will be formed. When the crystallization is satisfactory and is also thoroughly dry, the slide may be mounted in balsam and benzole.

(To be Continued.)

NOTICE.

TO SUBSCRIBERS:—The publishers of the JOURNAL regret to say that there are quite a number of subscriptions for the current year yet unpaid, and would respectfully request that all such be paid during the present month. If not paid before Sept. 15th, the subscriptions will cease.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, 53 Maiden Lane, New York, N.Y.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

MOUNTING ALGÆ.—G. Berthold has been experimenting with different media in the hope of finding something which would preserve marine algæ with the least possible disturbance of the structure of the protoplasm. Picric acid, osmic acid, and iodine dissolved in fresh water were tried without satisfactory results owing

to osmotic action, but solutions of osmic acid and of corrosive sublimate in sea-water gave good results. A few drops of a saturated solution of iodine in alcohol, however, added to sea-water, was found to give the best results. The algæ are first placed in the iodine solution for thirty seconds or a minute, and are then transferred to 50 per cent alcohol. This method of preservation may prove to be useful for zoologists as well as botanists.

LOCOMOTION OF INSECTS. — H. Dewitz has confirmed the observations previously made by others that insects are enabled to walk upon vertical surfaces by virtue of a glutinous exudation from the tips of certain hairs of the feet. By causing the insects to walk feet uppermost on a slip of glass under the microscope, drops may be seen emitted by the hairs which remain adherent to the glass. In the bugs having no hairs the fluid is exuded from the pores of the feet.

PAPER CELLS FOR MOUNTING. — Mr. G. Busk has used paper cells for mounting with great success. Some porous kind of paper is chosen, of suitable thickness, out of which rings are cut, which are then thoroughly soaked in benzol-balsam. When saturated with balsam they are placed on the slide when they become thoroughly hardened and fixed. Such cells are particularly adapted for watery media, glycerine, oil or balsam.

A good suggestion from the same author is to use a lead-weight of 2-3 ounces, supported on three short pins in mounting. Such a weight holds the cover well pressed down, while affording opportunity to clean the edges of the cover-glass.

A NEW ANALYZING PRISM. — The new prism devised by Dr. Schröder as an analyzer for the polariscope, which will be introduced by Messrs. Ross & Co., possesses considerable

advantage over the ordinary form. We may be able to give a more full description of it before long, but as a preliminary notice it may be said that it consists of a rhomb of Iceland spar cut in such a way that the ordinary and extraordinary rays diverge from each other at such a wide angle that one can be shut off by a stop on the surface of the prism.

The prism is mounted over the eye-piece, and the upper plane of the prism is in the plane of the image formed above the eye-piece. As the light from the ocular enters the prism it suffers double refraction, so that two images are formed, one beside the other. Either of these images may be cut off by a stop, the other being used for observation. Thus the prism acts without diminishing the field of the ocular.

A NEW OCULAR. — Dr. Schröder has devised a new form of ocular, some of which have been made by Messrs. Ross & Co., and subjected to trial. We have not yet seen them, but according to the testimony of a gentleman well qualified to judge, they are far superior to any oculars heretofore seen. At present we are unable to indicate the novel features of their construction.

NOTES.

— The second volume of Mr. Cole's *Studies in Microscopical Science* will be preceded by an introductory work, which has been announced in the following words taken from the Preliminary Prospectus:—

This work will be entitled "*The Methods of Microscopical Research*," and will contain chapters on "Instruments" and their uses, "Reagents," their properties and special applications, and the "Methods of Preparation" of typical examples, in which an exhaustive description will be given of the processes of section-cutting, hardening, staining, and injecting. A chapter will also be devoted to "Microscopical Art," in which full

directions will be given of the manner in which drawings can be made from the Microscope. Each section of the work will be fully illustrated with drawings and diagrams. The chapter on Microscopical Art, will include a sketch of the ways by means of which drawings may be reproduced, such as by photography, lithography, etc., and will be accompanied by suitable plates as illustrative examples. This work is complete in itself, and is to be issued weekly, beginning in June. The subscription price will be about \$1.50.

Two sections of the second volume of the "Studies" have been announced for publication on July 7th, the sections of animal and vegetable histology respectively. These sections will be issued in monthly parts, the subscription-price of each being about \$6.00 for the year. The third section will begin on July 14th, and be devoted to a series of popular objects, illustrated by slides and lithograph-plates, like the others. The subscription-price will be the same as for the others. We are unable to give the prices more definitely, as we are not informed of the postal charges.

— J. B. Schnitzler has observed the growth of a confervoid alga from a species of *Palmella*. In a rivulet near Lansanne he observed some bright-green cells enveloped in a gelatinous matrix, which he determined to be *Palmella uvæformis* Ktz., the cells being about 0.01 mm. in diameter. These were placed in a glass with water, and covered with a watch-glass. In two days swarm-spores were formed which attached themselves to the sides of the vessel and germinated, forming branched filaments. From these filaments in turn, were again produced gelatinous colonies of *Palmella*, by the breaking up of the filaments into spherical cells with gelatinous coats.

— The American Society of Microscopists have finished their session for 1883 at Chicago, and we regret that we have not received any report of the proceedings in time to publish them in this issue; but next month we hope to give our readers a full account of the sayings and doings of the Society, and also a report from the Minneapolis meeting of the A. A. A. S.

— We have received from the author, C. F. Millspaugh, M. D., a specimen sheet of a new work now being published by Messrs. Boericke and Tafel, entitled

American Medicinal Plants. It is to be completed in thirty monthly parts containing six plates with text each.

The work is quarto size, handsomely printed and the Plates are all that could be desired. We bespeak for it an extensive sale.

CORRESPONDENCE.

TO THE EDITOR:

Dear Sir:—The Cleveland Microscopical Society at a special meeting held July 24th, 1883, adopted memorial resolutions, a copy of which I enclose, with respect to the late Dr. W. B. Rezner, President of said Society, and instructed me to forward a copy to the AMERICAN MONTHLY MICROSCOPICAL JOURNAL with request that the same be published.

I am respectfully,

C. M. VORCE, *Secy.*

July 26, 1883.

"As members of the Cleveland Microscopical Society, we are called to mourn the loss of Dr. William B. Rezner, our president. He was one of the original promoters and most ardent supporters of our organization, and our first president, and we realize that in his loss one of our brightest lights is extinguished. For upwards of twenty years he had devoted attention to microscopical studies, and brought to his aid not only ripe scientific acquirements, but a rare inventive genius and an unexcelled mechanical skill. In his scientific studies and methods he was cautious and painstaking, and one of his most distinguishing characteristics was his indomitable perseverance in following out an idea to its result, and learning the actual and ultimate truth to which it related. In such pursuits no obstacle was sufficient to deter or discourage him. Unaided and uninstructed he met and overcame innumerable obstacles in his favorite pursuit, by his acute inventive genius and his manipulative skill, and the amount of labor he has spent in the determination of difficult questions which have arisen in the course of his investigation, can never be fully known, although it is known to many of his friends to be enormous.

"When, many years ago, in the earnest study of microscopy, the resolution of difficult tests attracted his attention, he devoted much time to that subject, and with the most untiring patience worked

out success with all the most difficult ones. In this work, especially relating to ruled lines, he devised methods and apparatus, much of which he constructed himself, by which success was greatly facilitated. None of his early devices were published by him, but some have been credited to other less modest investigators.

His best known invention relating to the resolution of tests was the plating of micrometer lines with silver, by which method the difficulty of resolution was so much decreased that one of the best known microscopists described the result as "altogether too easy to be interesting." By this method Dr. Rezner succeeded in resolving the famous band of 120,000 lines to the inch, which resolution he was the first to accomplish, and which he exhibited at the Buffalo meeting of the American Society of Microscopists, and this method has since had extensive application. Dr. Rezner devised and constructed a special traversing apparatus for use in the resolution of lined tests, and among other devices an improved fitting with universal movements for the Wenham reflex illuminator. He personally constructed several different forms of the Wenham reflex illuminator, numerous solid oculars, immersion illuminators, and various prisms and special fittings of many kinds, for use in special investigations in which he was from time to time engaged. His form of mechanical finger is widely known and used, and is the most generally available of any form yet described. Various other forms of microscopical apparatus in common use were modified and improved upon by him, and he had but lately constructed a spectroscope and spectroscopic apparatus, upon which he contemplated still further improvement, when death cut short his useful life.

"But we mourn not only our president, but also the loss of a faithful friend. His cordial and genial manner endeared him to all, and the remembrance of his patient attention to all discussions and suggestions, and the modest manner in which he always presented the results of his own ripe experience, will remain with us as worthy of the man and of our imitation. Notwithstanding his modest and unassuming manner, he was a man of decided views and firm convictions; his opinions, though not vaunted, were the result of careful thought and were not easily changed. Of deep religious con-

victions and the most rigid and refined integrity, Dr. Rezner, was, in social life, the soul of wit and mirth, and was one of the most enjoyable companions that could be found. His circle of acquaintance was unusually large, and he was so universally esteemed by all who knew him, that it may be truly said he had no enemies, for his political adversaries, while opposing, yet admired and respected him.

"In his professional life he was a warm friend alike to his brethren and his patients. He was ever ready with aid and advice to the younger members of the profession, many of whom he has guided to a successful and honorable career, and by even the most talented of his brother physicians his advice was sought and availed of. To his patients he was endeared by all his noble qualities of heart and mind so deeply, that many homes besides his own now feel the desolation of his removal. To his bereaved family our stricken hearts go out in sympathy, and with them we mourn in common the loss of one not only endeared to us by every memory, but who has proved to us our chief dependence and stay. To us, as to them, his loss is irreparable, and we bow in sorrow to the manifestation of that providence of Him whose will our departed friend ever deemed his guide, and whose protecting care and watchful guidance we prayerfully invoke for them."

TO THE EDITOR:

Dear Sir:—As a worker in microscopy in my humble way, I wish to say a few words on the matter of American and German lists of objectives. Let us say, I want a 2-inch glass. I, of course, want a good glass; in fact, I want a perfect image. I send to an American maker of repute for his list. What do I find? 2-inch \$25.00 or \$30.00. I look at a German list: I see a first class 2-inch, \$7.00 or \$8.00. Is it a wonder if reason is confounded? Why, if a first class 2-inch is worth \$25.00, this German maker is a fool or a liar. But, no, he can be neither, seeing he is a maker of wide repute; his glasses must be good! they are used in some of the first institutions of learning in the world! Admitted his 2-inch at \$7.00 is a good glass, what can it possibly be that makes the American 2-inch worth \$25.00? What can a man see with a 2-inch to justify such an outlay? These are some of the thoughts begotten by a survey of these respective lists.

Something is wrong here. What is it?

Simply a false notion of angle of aperture. The American list implies that an angle of 40° makes a first-rate glass of the 1-inch, and a third rate of the $\frac{1}{2}$ -inch, whereas, the facts in the case are, that an angle of 40° is the same thing in the one glass as in the other, and will do as good work.

True, the American list offers glasses lower than the German, but the list tells us, they are third rate, and we don't want third-rate glasses. The American list is a slap in the face of both student and professor, and a compliment to the man who is in microscopy what the owner of a \$2000 racer is in social economy, be that much or little. The list implies that first-class objectives are neither for professor or student, by tacking their titles on to second and third rate lists. Now, it may be after all, the "professional" and "students" glasses are first-rate in corrections; but the maker knows better than I; and while he calls them second and third rate, I must take him at his word; and I would say to him, if these glasses are second and third rate, do make us some first rate glasses of moderate aperture as low as the Germans make them; if these are first-rate, say so.

C. ONDERDONK.

RUGBY, TENN., June 11, 1883.

MICROSCOPICAL SOCIETIES.

At a meeting of the Royal Microscopical Society held in June last, a specimen of rock from Southerlandshire was shown which was said to contain the first Eozoön remains that have been discovered in Great Britain. The President remarked that the specimens he had examined did not carry conviction of their eozoön nature, but owing to the fact that the rock is not in its primitive condition but has been infiltrated with mineral solutions which have replaced each other perhaps several times, it is difficult to decide upon the nature of the structure observed.

NOTICES OF BOOKS.

Normal Condition of Cellular Structure, and Peach Yellows. By D. P. Penhallow, B. S., Botanist and Chemist of Houghton Farm, Mountainville, N. Y. Diseases of plants, Series III.

Nos. 1 and 2. With four colored lithograph Plates. Pamphlet, large 8vo. pp. 45.

The present pamphlet is one of a series published by the Houghton Farm, detailing the results of long-continued experiments to determine the relative condition of the cells of plants in health and disease. The first part is devoted to "The normal condition of vegetable structure, with reference to cell contents." Experiments were made with trees of widely different relationship, growing in different localities, and under conditions of cultivation, as well as in the wild state, and also at different seasons of the year.

Twenty-two different trees were selected and three hundred and sixty examinations made. The results are given concisely and are worthy of careful study.

Part 2 is devoted to an investigation of Peach Yellows. To further this investigation 150 circular letters containing printed questions were sent to prominent growers, and it is surprising to find that only four answers were received. The examinations were carried on for an extended period, both chemically and microscopically, and very satisfactory methods for the treatment of the disease seem to have been arrived at.

The work also contains very convenient tables of comparative measures (metres and feet) on temperature (Cent. and Fahr.)

Exchanges.

FOR EXCHANGE.—Slides of pollen of pitch pine, *Pinus rigida*, with the connection stained, for any named slides of algae. Dr. C. F. Millsbaugh, E. M. S., Binghamton, N. Y.

WANTED.—*Trichina Spiralis*, *Pleurosigma* Ang., or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

FOR EXCHANGE.—Well-mounted double-stained vegetable preparations, also, a few first-class injected preparations for other well-mounted slides. N. A. Richards, St. Louis, Mich.

WELL-MOUNTED slides of *Polycystina*, transparent and opaque, for any well-mounted slide. P. C. Cole, M. D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

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No. 9.

The Student of Nature.

BY M. C. COOKE, M.A., LL.D., A.L.S.

[Dr. Cooke has recently favored us with a copy of an address delivered in the year 1881 as President of the Hackney (Eng.) Microscopical Society. Its fresh and vigorous style, and the food for thought to be found in it, induces us to offer the following abstract to our readers, who, we believe, will not be slow to appreciate the facts and fancies so well presented.—ED.]

Whether you have done well or ill, it is my duty, as well as privilege, to occupy the honorable position which you have assigned to me. I will not dispute your right to obtain all the work possible out of your President; if he accepts the privileges he is bound to perform the duties. Here and there the candle is burnt at both ends; if not a thrifty practice, at least it makes a great blaze. If your demands are for an opening, as well as a closing address, I will not demur. To make the most of his opportunities is commendable in a student. This is an age of tall talk and long talk, as the records of our Senate will hereafter testify. May it not also be, in some sense, an age of work—of telephones, perhaps, but also of electric lights and torpedoes.

Students we all are, and as such I would address you. The wise man knows and feels that he is only a student, never a master. Whether he will or no, the most unstudious theoretically, is a student practically. It depends upon himself mostly whether his studies are beneficial. If the

mind be receptive, operative, well disciplined, every morning will witness the rising of a wiser and a better man. . . . We meet here to-night with all our individualities reserved, but with a common object—the commencement of a new year of mental activity. We have reviewed the past. We have taken stock, but none of us are insolvent. We have passed the balance of gains to the capital account, and, with an enhanced principal, await in confidence an additional increment of interest in the future. We have rescued our talents from the mud.

And yet what diverse creatures we are. We follow different occupations by day; we are interested in different recreations at night. Herein lies the advantage of societies with a catholic programme. The individual man retains his individuality. Every one runs after his own butterfly, without fear of his neighbor's corns. Specialists many of us are, but for the time our specialities are forgotten. For the time being we are students in conclave. It seems to me that your President, at least, should forget that he is a specialist when called upon to preside over you. His sympathies should be extended to all; a general—in fact as well as in name.

Sometimes it may be true that the specialist is a man of one idea. Oftener the converse is the case, and the man of one idea, as he is supposed to be, has a wide experience and extended sympathies. One-idea men are very rare amongst biologists. It is a luxury they cannot afford themselves. The relations of one section to another is so intimate, researches in one direc-

tion refract so much light in another, that one-idea men would be mummies. Let us banish this one idea. . . . Genus and species are riddles; at least to some men. In the natural sciences they are made the subject of definition. In certain terms the attributes of a genus are laid down. Such species as conform are included within it. Such as do not are excluded.

"Men who devote their leisure to persistent, more or less systematic, examination, investigation, and elucidation of some of the forms of animal or vegetable life." This is the diagnosis of our genus. Let the name be what you please; names go for nothing if the *thing* be well defined. Some say Naturalist, some say Microscopist, some say Student. It matters little, so long as the attributes are present. "Let each be persuaded in his own mind."

Calcine a specimen of this genus in the crucible of experience, and analyze the ash. By this means we discover *improved health*. Verily, robust health is not peculiar to the naturalist. Neither is dyspepsia and debility an essential of his nongener. Yet do we contend that active minded man, given a change of thinking, and a necessity to constitutionalize himself in search of spoil, becomes inheritor of more substantial vigor, of conditions consistent with health. Rubbing his ledger with the tip of his nose, week in, week out. Dreaming forever of sum totals, and ten per cent. wears the flesh and the spirit. Aught that dispels the demons of rebate and discount, returned bills and notaries public, is good for the body of man as well as the soul. What matters it whether he runs off his dignity after a dragon fly, or stirs up a muddy puddle with a bottle at the end of a stick, so long as he shakes off the dust of his counting-house, and tries to fancy himself a boy again. . . . A healthy brain is a vigorous brain. It does not require absolute cessation from action to give repose. "Thinking of nothing at all" is a condition

which some of us cannot comprehend. It is no evidence, in its possibility, of a healthy mind. The old adage "better to rub than to rust," is true enough in this connection. Food is as necessary for the mind as good food for the body. Generous diet for strong men, but milk for babes.

What advantage has the naturalist psychologically as well as physiologically? Let no one contend that a change of thought is not beneficial. I cannot believe that an earnest man of business can shake off the thoughts of his shop at a moment's notice. That he can rid himself of his last ten hours' occupation without a powerful stimulant. A new and almighty agent must work in him, in order to dispel the almighty dollar. Give him but a new direction in which his active mind can work, and let it be potent enough, and it will reign supreme. Nothing exhausts, and shatters the mind to fragments, equally with one eternal round of the same dull theme. The same brick walls, the same squaring of the circle, the same click-clack of bobbins and spindles, the everlasting *£ s. d.* Let this dull round go on from year to year, and the product is a mummy. Intellect there is none, soul there is none. Nothing but a perambulating ready reckoner.

Contrariwise, if he changes his own shop for nature's workshop, and shuts one but to open the other, the change steals like a tonic over his debilitated mind, and rehabilitates him for the work of the morrow. Poor little man, much to be pitied, who can sit down beside an ant-hill, and see the busy little community running hither and thither, and go home with nothing to think about. . . . Happy the choice that selects for recreation activities that become a discipline. If we admit discipline to be good for the schoolboy, the sailor, and the soldier, then why not for ourselves? Did we never see a young man of rare promise flash for a moment, then go out, like a meteor,

into utter darkness, for the lack of self-discipline? All systematic study is a discipline for the mind. Of all studies the classificatory sciences are the best disciplinarians. The drill sergeant is invisible; there is no sense of constraint; there is no feeling of rebellion against authority; the impulse is gentle as the touch of a feather, potent as a lance of steel. The habit of grouping or classing objects according to affinities or resemblances, arranging in genera, families, and orders, commends itself to the mind with experience, that, all unconsciously, the love of order spreads from the hours of recreation to hours of work, and the pastime of the evening benefits the business of the morrow. Let no one dream that time thus spent is lost. Atom by atom the little worms may build unseen, beneath the surface of the sea, but by and by the coral island becomes a hard, inflexible rock. Your earnings, if the coin be good, will be entrusted to a good banker, and the principal will realize you a good interest in some future day. A little experience may be of no use to you to-day, but twenty years hence it may be worth gold. It matters not *now* that the imprisoned steam blows off the lid of a kettle; in twenty years it drives a railway train from Darlington to York.

Undoubtedly temperament is a great factor in the account. *Studentia nascitur non fit*. The student is born, not made. There are men possessed of minds that cannot remain idle; there are others which are spurred into activity only by continuous exertion. The latter seldom pay for the spurring; the former only need the rein. It is our duty to point the road, and not to drive men into it. The mariner who is not warned by the sight of a storm drum will not be convinced by kicking. . . . Any and every science gains by accession of earnest but humble workers. Amateur scientists, if you will, lovers of science as a recreation

—call them by any name, so long as they do not treat as absolute plaything that which they use as one—these may do much, and might do more, for universal knowledge. From the ranks of these, heroes may come. A true word is often spoken in jest; truth may be even traced to a plaything. A kite may bring down the electric current from the clouds. We who profess to follow some branch of natural science, as the business of our lives, cannot afford to laugh at, or despise, those who use it as a pastime; we ourselves began it, perhaps, in a like manner. We were not always so earnest; we dallied with the tempter, played and danced about it, but at last were caught in the toils. Many a man has played himself into science in earnest.

Most societies like ours do not make any pretence to be more than playgrounds of science. Their members work at their lessons in a very strict school day by day, and these are their playgrounds, in which they recreate body and mind by a good romp. The wisest of kings has said that there is "a time for work and a time for play," and they would be fools who employed all time for one or the other. Let not the beetle-catcher or the bug-hunter apologize for himself that he is only an amateur; rather let him thank God that he is not as some other men, and take courage. Time was when Hugh Miller was a plain stone-mason, and nothing more. Then, as he chipped at the old red sandstone, he made playthings and friends of the odd fish he found there. By and by he grew in earnest, and worked at them, but at first he only played with them. Playthings to-day may be tools to-morrow. It depends more upon the child than the toy how long childhood will last. Whoever has learnt to look upon Nature with a loving, an enquiring eye, has taken a first step towards understanding her.

Those who would catalogue the advantages of rambling in the bye-

paths of science would find it a long job.

If you would learn the arguments on the other side, ask of those who repudiate playing at science.

Perhaps you will learn that it spoils a man for business; that he will be thinking of tadpoles when he should be striking a balance; that he becomes effeminate over books and cockchafers; that energies are wasted in play that are wanted for work; that it is enough to fight a hard battle all day. But these are only bogies to frighten fools. Those who have tried "recreative science" know well enough that it is recreative, and that it bears no invidious relationship to the occupations of life.

Perhaps you may be told that it makes men sullen and morose, silent and reserved, cadaverous and miserable. Let no one suppose that we claim to be other than human. We have also our pleasures as well as other men, but not the same pleasures; the difference is qualitative, not quantitative. Our enjoyment is not the less keen because it is less boisterous. We have no need to pray that "the evening's amusement may bear the morning's reflection." That is a prayer we will leave for those whose necessities require it.

Perhaps you may be told that it is useless and unproductive, waste of time, waste of power. Mercenary motives are the last impulses, and the very last that influence even the naturalist. That, at least, it is equal in usefulness, in productiveness, to the thousand and one devices employed for killing time can be demonstrated; that it is superior may be inferred, as the opinion of some who have applied the test of experience.

Perhaps it is not needful to battle with such images of clay. Let us rather enquire what is the ideal to which a student should aspire.

This work has been done, and well done. Why need we to do it again? Turn to the early pages of Charles

Kingsley's "Glaucus," and there contemplate his full-length portrait of an ideal naturalist. I would not attempt to improve it. The lines are drawn by a master's hand, and one who had deep sympathy with his subject. "I should say," he wrote, "that the qualifications required for a perfect naturalist are as many and as lofty as were required by the old chivalrous writers for the perfect knights-errant of the Middle Ages." Then he commences with the physical requisites of a good naturalist. In a few lines the outline is drawn. Then he adds, "for his moral character he must, like a knight of old, be first of all gentle and courteous, ready and able to ingratiate himself with the poor, the ignorant, and the savage. Next he should be brave and enterprising, and withal patient and undaunted, knowing that the kingdom of Nature, like the Kingdom of Heaven, must be taken by violence; and that only to those who knock long and earnestly does the great mother open the doors of her sanctuary. He must be of a reverend turn of mind also; not rashly discrediting any reports, however vague and fragmentary, giving man credit always for some germ of truth, and giving nature credit for an inexhaustible fertility and variety, which will keep him his life long always reverent, yet never superstitious, wondering at the commonest, but not surprised by the most strange; free from the idols of size and sensuous loveliness; able to see grandeur in the minutest objects, beauty in the most ungainly; estimating each thing not carnally, as the vulgar do, by its size, or its pleasantness to the senses, but spiritually, by the amount of Divine thought revealed to him therein; holding every phenomenon worth the noting down; believing that every pebble holds a treasure, every bud a revelation; making it a point of conscience to pass over nothing through laziness or hastiness, lest the vision once offered and despised should be withdrawn, and looking at

every object as if he were never to behold it again.

"Moreover, he must keep himself free from haste and laziness, from melancholy, testiness, pride, and all the passions which make men see only what they wish to see. Of solemn and scrupulous reverence for truth, of the habit of mind which regards each fact and discovery, not as his own possession, but as the possession of its Creator, independent of us, our tastes, our needs, or our vain glory. And last, but not least, the perfect naturalist should have in him the very essence of true chivalry, namely, self-devotion; the desire to advance, not himself and his own fame or wealth, but knowledge and mankind."

"These qualities, however imperfectly realized in any individual instance, make our scientific men so worthy. Men for the most part with manful heads and yet of childlike hearts, who have turned to quiet study in these piping times of peace; an intellectual health and courage which might have made them, in more fierce and troublous times, capable of doing good service with very different instruments than the scalpel and the microscope."

I might have added hints of my own conception how association would assist not only in the development of such students, but how their good qualities would be intensified. I need not appeal to the sympathy of numbers, to the strength of fellowship, to *esprit de corps*, to healthy emulation, to the encouraging "excelsior" of companions, to all that commends public schools, universities, and even the every day commercial associations, which, one and all, take advantage of the power which is inherent in association.

Pollen-tubes.

BY J. KRUTTSCHNITT.

An article of mine on Pollen-tubes appeared in the June number of your JOURNAL for 1882.

Since then, I have corresponded with some of the highest authorities on Botanical Science, and have submitted some of my preparations to them, with no result other than receiving a few complimentary notices on the workmanship of my preparations. A gentleman in Hoboken has, however, recently kindly placed in my hands for examination a slide of a portion of an ovary of *Monotropa* with the remark that the contact of a pollen-tube with the micropyle of the ovule could be seen in it. The slide did not show me what I was led to expect; but it furnished me with a clue whereby the difference of opinion between the text-books and myself, as to the microscopical interpretation of the pollen-tubes might be explained away.

On the slide referred to, the structure—a flattened tubular fibre—seen in contact with one of the ovules has no feature in common with the pollen-tubes as they appear on the stigma; I consider it an abnormal development of a fibre of the conducting tissue. Hofmeister in his works gives a diagram of a similar structure, and designates it a monstrous development of a pollen-tube.

The writings of Schacht and Sachs which I have chiefly studied, teach that the pollen-tubes after their emission on the stigma, penetrate into the conducting tissue lining the stylar canal, where it is said the tubes find the material to vegetate and grow upon until they reach the ovary, where the conducting tissue again assists in guiding the tubes to the micropyle of the ovules.

My long continued and varied observations, made with entire freedom from traditional bias, have taught me on the contrary that the pollen-tubes after their emission on the stigma are very soon lost amongst the papilla of the stigma, where the fovilla they contained is discharged, which, indeed, may be traced in streaky and cloudy aggregations in the midst of the conducting tissue all along the style to the head of the ovarian cavity. At

that point the fovilla appears evenly distributed in the fibrilla of the conducting tissue ; it permeates the tissue of the placenta, and accompanies the vascular fibre which runs through the funiculus to the hilum of the ovule. I have always found the ovules attached in such a way on the funiculus or raphe, or where sessile, on the placenta, that their micropyle is brought in easy and natural contact with the fovilla carrying fibrillæ or papillæ of the conducting tissue. In *Cereus grandiflora* the long funiculus is covered with papillæ on the ventral side.

The pollen-tube question as above outlined may be brought within very narrow limits ; it may be stated as follows :

Do the pollen-tubes such as they are when emitted on to the stigma, continue their separate existence and course to the micropyle of the ovules under the guidance and nurture of the conducting tissue ?

Or do the pollen-tubes discharge their contents amongst the papillæ of the stigma, which is the aggregate head of the fibrillæ of the conducting tissue of the style ; thus carrying down the substance of the pollen only, to the ovary as an entirety, so that whenever the papilla, around the micropyle of the ovule, come in contact with the conducting tissue and its fibrillæ, the ovule is fertilized by absorbing the substance of the pollen-grain ?

Thus according to one theory the functions of the conducting tissue would be to conduct the pollen-tubes to the ovary, whilst according to the other, the conducting tissue would only serve as a vehicle to carry the substance of the pollen to the same destination.

What I stated above on the distribution of the fovilla in the conducting tissue is shown in sections of the ovary of *Cereus grandiflora*.

It would puzzle an observer greatly to trace the course of the pollen-tubes from the sessile stigma of the poppy (if such exist, I have not

been able to discover any ; in fact, only on a comparatively small number of plants are pollen-tubes visible on the stigma) down to the many parietal divisions of the ovary. A transverse section reveals, however, the *modus operandi* and the distribution of the bundles of the conducting tissue. The papillæ on the rays of the stigma correspond with as many bundles of conducting tissue which descend in the wall of the ovarian capsule to the base of each parietal division where they appear as a loose net-work on the back of the placental surfaces, both of which are beset with numerous ovules.

A Microscopist Rambling.

One Sunday morning, in August, bright and clear, the writer was in Birkenhead, which is situated opposite Liverpool, across the river Mersey. Starting out aimlessly, more in search of change and rest than with any other end in view, it was a question whether to climb the hill upon which the celebrated Bidston observatory is situated, from whence could be seen the river widening into the broad bay, and the stretch of water bounding the horizon beyond ; or to take the opposite direction, cross the ferry to Liverpool, and there look for a means to reach a secluded spot with fresh air, and freedom from the noise and travel of the city. The latter course being chosen, we were soon on the other side, and, not caring to go up into the city if a boat could be found running to a sandy beach somewhere near by, we did not leave the docks, but sauntered along the river where there was little observance of the day. Excursion-boats were awaiting the time of departure, and rapidly filling with people ; steam-tenders were delivering cargoes of live-stock, cattle, sheep and pigs, and it was amusing to watch the serious ; systematic method of an elderly person from the Emerald Isle who was counting his sheep as they passed before him,

being greatly aided in this operation by a stick with which he pointed out each branded animal as it passed. There might have been an earthquake or an explosion of dynamite close by, without disturbing the record in the least, so intently were his faculties engaged in the work in hand.

Finally we discovered a boat getting ready to leave for New Brighton, and without the slightest idea of where New Brighton was, and caring quite as little so long as there was a sandy beach there, we inquired regarding the latter, and the response being in every wise satisfactory—"When you're at New Brighton you're right on the beach,"—we lost no time in getting on board.

A short sail down the river and the destination was reached. The town is, no doubt, a desirable place of residence, situated as it is, upon elevated ground near the mouth of the Mersey, with a commanding view of the river. But our course was for the beach, and for some distance along a promenade running in front of a long row of shops fronting the water. Every shop was an eating saloon—dozens of them in a row—and the bills of fare were alike in all of them with the trifling exception that in some cases "roast beef, peas and potatoes," were 1s. 3d., and in other cases, 1s. only.

We strongly suspect, however, that some enterprising proprietors occupy two adjoining shops and, with a laudable desire of enticing the custom of the impecunious as well as their more favored fellows, they charge a shilling on one side of the dividing wall and "thrippence" more on the other.

Leaving the elevated promenade we made our way across the wide beach to some rocks jutting out into the water, upon which stands a lighthouse. Fortunately it was almost low-water, and the rocks were bare for a considerable distance from the lighthouse. Here and there we picked up a

stranded jelly-fish, and occasionally a pretty shell, and bits of sea-weed, but there was one large pot-hole in the sandstone, which the tide had left quite full of water, that was fringed all around with a short growth of beautiful red seaweed, specimens of which were collected for future examination. It was one of the beautiful natural aquariums one finds about a rocky coast, but at this time there was nothing else left within it. We found nothing more upon the rocks except the barnacles which were abundant on the base of the lighthouse, and as the tide has a long range in the Mersey they covered the base of the tower to a greater height than we could reach.

Strolling away from the lighthouse, an abundance of the common mussels was found, large numbers of which are collected along the beach for food. We gathered a few in a handkerchief, and, finding a hillock of clean sand beneath a bold sandstone cliff, sat down there to dissect the animals with the aid of a pocket knife and a common pocket lens. While thus engaged, two laboring men came near and one of them asked, "Have you got a crab?" "No, not a crab," we replied. Looking on a few moments they turned away and one said, "He's analisin' a *mousel*." Opening the shell carefully, we were soon able to find the different organs, and observe their relative positions. Using the magnifier the beautiful structure of the ciliated organs with the parallel bands of cilia could be clearly seen, and even the incessant movement of the cilia was distinctly shown by a peculiar play of light reflected from the surface of the membranes which were covered with moving cilia.

The pulsations of the heart were also readily observed under the low-power lens.

Wherever the microscopist may go there will always be something to attract observation, and worthy of notice.

The Polari-Spectro-Microscope.

This instrument is a combination of microscope, spectroscope and polariscope, by means of which certain optical properties of bodies can be studied with far more delicacy than by any other means. It was devised by Dr. A. Rollet, of Gratz. Fig. 27 represents the instrument complete; fig. 28 is a section of the apparatus beneath the stage.

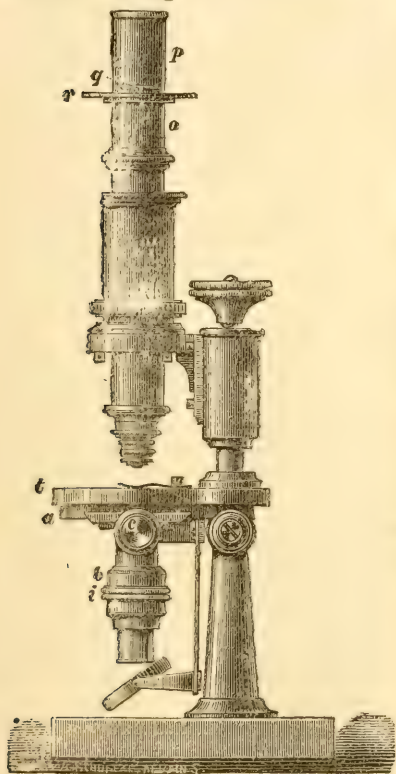


FIG. 27.—POLARI-SPECTRO MICROSCOPE.

In the ordinary micro-spectroscope the image of an object slightly out of focus is received upon the narrow slit of the spectral-ocular, and a narrow band of that image is examined through the prisms. In this way the absorption-bands can be studied perfectly well in the case of the greater number of objects. But only very minute portions of an object can be studied in this way. Before the spectroscopic oculars were introduced,

the plan was to throw a spectrum, or a part of a spectrum, into the field of the microscope along with the object, and to study the object in the different colors — in monochromatic light. This is the plan adopted in this instrument. The spectrum is formed by the prisms *f*, (fig. 28) the slit being at *s*, and projected into the field of view by the lens *g*. With an objec-

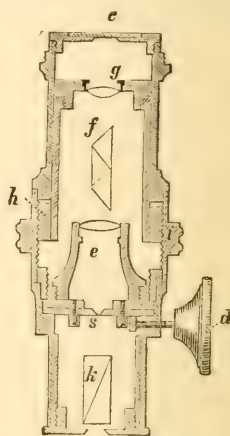


FIG. 28.

tive of medium power the entire spectrum can be seen at one time. The object may be moved across the spectrum by the stage movements, or, by means of the screw *c* (fig. 27), the spectrum can be moved laterally over the object. For examinations in monochromatic light this is the only appa-

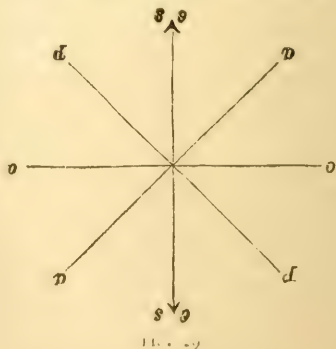


FIG. 29.

ratus required; but the purpose of this instrument seems to be rather to examine the conduct of objects with polarized light, and especially to de-

fect the slightest property of double refraction. For this purpose a polarizing prism k , (fig. 28) is added, and a selenite plate c is placed above the lens g , giving a red color when the analyzer is used, which is placed in the ocular with the ordinary graduated scale r , and index q .

When light is thrown into the instrument from the mirror it is first polarized by the prism k , the ordinary ray passing through the slit s and the lens c , is spread out into a spectrum by the prisms f , and focussed upon the object by the lens g . But before it reaches the object it has to pass through the plate of selenite c . Here its plane of polarization is changed. In an ordinary polariscope one part of the ray is retarded more than another part, so that when the light from the selenite reaches the analyzer, the two portions become partially reunited, and produce color. But here we have another phenomenon which is quite too complex to be explained in this place, for we have to deal with the effect of the selenite upon the light decomposed by the spectroscopic prism. The most that can be said is, that when the apparatus is arranged according to the plan shown in fig. 29, there will be a dark interference-band in the spectrum, the position of which will depend upon the thickness of the selenite film. In this figure, ss represents the direction of the slit of the spectroscope, pp , the plane of vibration of the polarized ray, aa the plane of vibration of the analyzer, and oo the plane of vibration of the ordinary ray in the selenite film.

Since the position of the narrow interference-band in the spectrum depends upon the thickness of the selenite film, it follows that by placing another thin film above the plate, either resting upon it or upon the stage of the microscope, with its optical axis coinciding with the first film, the dark band, which we will suppose to be in the yellow of the spectrum, moves away from that place, and the yellow light passes through. Now,

any doubly refracting object will act the same as the additional film of selenite, so that if we examine a piece of muscle, for example, which has been found to possess the power of double refraction, the effect will be the same as increasing the thickness of the selenite; and the bit of muscle, being smaller than the dark band, will become luminous upon a dark ground.

To use the instrument, the object to be examined is placed in the dark interference-band. If it has no power of double refraction, it will, in all azimuths, appear dark, but if double refracting it will, in certain azimuths, appear bright on a dark field.

Mounts and Mounting.

Continued from page 156.

Asparagine, another choice crystallization, must not be omitted. The finest results are obtained by making a hot saturated solution in water, of which solution a drop must be evaporated on the centre of the slide, by means of very gentle heat. The slide must be removed from the influence of heat as soon as an amorphous film replaces the solution, and as the slide cools the crystals will appear. Another form approaching closely that of wheel or circular crystals, described earlier in my paper, may be obtained by having the solution of less strength.

It has probably been noticed that the crystals hitherto described have all been obtained from aqueous or alcoholic solutions, and it is a fact that in each case, although I have experimented with other solvents, as ether and chloroform, the best results have been obtained in the manner described; but I cannot leave this part of my subject without mentioning two crystallizations (those of salicine and santanine) of which the best solution can be obtained by methylated chloroform; but even in these two cases solutions do not give the best results, and it is noticable that in all, or nearly

all cases where a very volatile solvent is used, the results are not so good as when a slower process of crystallization can be employed.

In the case of salicine and santonine a solution does not give so good a result as the process of fusion, and this process may be adopted in at least two different ways: by fusion only on the surface of the slip and fusion between the slip and cover glass. The best results I have obtained by placing a small portion of either salt on the centre of a slide and heating until fusion takes place; and here I may warn you that a greater heat is required than in any other crystals mentioned, and although in other cases the slip may be held between the fingers, I would recommend that now a clip be used. One of those known as American clothes pegs answer admirably. When fusion has taken place, it is necessary to spread the fused mass with a hot needle over the desired surface, keeping the slide still heated until this is done. As the slide cools the crystals will be formed. I have been informed that for these slides castor oil is the best mounting medium, but have invariably mounted them in pure Canada balsam, and I think with good effect.

This process of fusion will be found to be of great advantage in many other cases; but fusion of the second kind mentioned may also, in the case of santonine, be chosen with good results, as the process of fusion under the cover-glass, renders the film of extreme tenuity, and in this case produces a slide of wavy crystals, extremely beautiful under a spot lens, and also very permanent.

Of another mode of producing interesting micro-crystallizations, that of sublimation, I can only indicate broadly the methods to be employed, as I have not experimented much in this direction; but it is a process which must not be passed over, yielding, as it does, good results in the case of benzoic acid, anthracene, anthraquin-

one, iodine, naphthaline, and many others.

To obtain results by this process, it is really only necessary to place a little of the material in a small box, — a match box for instance, and cutting a hole in the lid of the size required, placing a slide, with its well cleaned surface downward over the hole. If this is placed in a warm place, the material will sublime and condense again on the glass above. Of course, should great heat be required, in the process, it will be necessary to use something better than the box described; and the material to be sublimed may be placed in a test tube, and the test tube being held by a clamp at the proper distance above a spirit lamp, the slide may rest with its central portion over the mouth of the tube, and will thus receive the sublimation.

Of the crystallization of fatty acids, which would of itself afford ample occupation for any one wanting a subject, I can say nothing now.

And of the combination of two or more salts, which is a subject requiring, and which will reward, any amount of investigation, I can only outline the matter by saying that fine slides have been produced of various salts of copper and magnesia, copper and ammonium, copper and potassium, chromium and potassa, chromium and ammonium and many others, and of which process of combination the platinocyanide are fine illustrations.

Some crystals possess a power known as dichroism, or the presentation to the observer of two colors, according to the direction of the light, and which is said to depend upon the absorption of some of the rays of light in the passage through the crystal. This power is possessed by acetate of copper, chloride of paladium, and by the oxalate of chromium and potash and others. Other crystals possess a character which by some is termed dichroism, but which is, I think, most properly designated fluorescence, and and is well shown in the platino-

cyanides, more particularly those of magnesium and yttrium.

Another peculiarity of some crystals was in 1837 designated by Fox Talbot as analytic, that is, they have the power of analyzing polarized light like a tourmaline, and when examined on the microscope stage, do not need the analyzer above the objective. This power is possessed by the platino-cyanides, boracic acid, murexide, hippuric acid, nitrate of potash, iodo-sulphate of quinine, and many others.

The scientific cause of these powers

of dichroism, analysis, and fluorescence, as well as polarization I pass entirely by, leaving them to be dealt with by others much more fitted for the work. And in concluding, I would ask any who are tempted to take up this subject, either in a scientific or *dilettante* manner, to jot down for their own or other's benefit anything which arises from their experiment, as it is from such notes as those, made at my work-table, that I have ventured to prepare this paper,

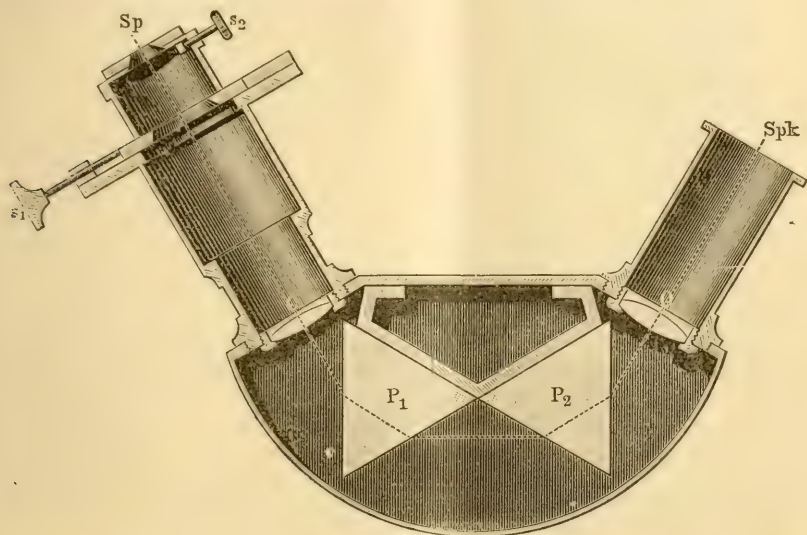


FIG. 30. — ILLUMINATING APPARATUS FOR MONOCHROMATIC LIGHT.

Illuminating Apparatus for Monochromatic Light.

The use of monochromatic light is frequently desirable in microscopic work, especially blue light. The usual method of obtaining colored light is to pass sunlight through colored glass, or through a colored solution, such as the ammonio-sulphate of copper for blue light. Mr. Zeiss has constructed an apparatus (after Harnack) for this purpose which is illustrated in fig. 30. By means of two prisms P_1 P_2 , of strong dispersive power a spectrum of considerable length is projected upon the object

from beneath, so that with high powers the entire field is illuminated with a near approach to monochromatic light. The light enters the instrument through the slit Sp , which is adjustable in width by the screw S_2 , and passes through the prisms and the lens at O forming a spectrum at Spk where the object on the stage is supposed to be situated. By moving the slit by the screw S_1 , the spectrum is caused to pass over the object, the different colors following in succession. The instrument may be used for low-powers with ordinary daylight, but for high-powers sunlight must be employed.

The American Society of Microscopists.

BY PROF. D. S. KELLICOTT.

The Sixth Annual Meeting of the American Society of Microscopists was held this year in Chicago. It began Tuesday, August 7, and closed the following Friday. There were about one hundred present; and in the zeal and earnestness of the members no meeting of the Society has surpassed it. The whole time of the eleven sessions was given to reading and discussing papers, describing new apparatus, or the exhibition of objects and methods of work. A part of one session was devoted to exposition of methods by various experts. Special tables were provided at which the various operations were going on, so that the members could visit each in turn, at pleasure. At one table Dr. Lester Curtis explained his method of injecting the blood vessels of a cat; at another Prof. Burrill was staining and mounting Bacteria; Professor Chester showed his new method (cover removable) of dry-mounting, etc., etc. This novel feature will be repeated next year, as it proved a most interesting and useful hour. The arrangements, as before, will be under the efficient direction of Mr. E. H. Griffith. More than ninety new members were elected. The meeting next year occurs in Rochester, N. Y. The officers are as follows: President, Hon. J. D. Cox, Cincinnati, O.; Vice-Presidents, Prof. Wm. A. Rogers, Cambridge, Mass., and Prof. T. J. Burrill, Champaign, Ill.; Secretary, D. S. Kellicott, Buffalo, N. Y.; Treasurer, Dr. Geo. E. Fell, Buffalo, N. Y.; Members of the Executive Committee, Prof. A. H. Chester, Clinton, N. Y., Gen. Wm. Humphreys, Jackson, Mich., and Dr. H. A. Johnson, Chicago, Ill.

On Tuesday evening occurred the annual conversazione and reception tendered the Society and the State Microscopical Society of Illinois, by the Calumet Club, at their new and elegant club-house. There were two

hundred and fifty microscopes in position on temporary tables, in two large and beautifully furnished parlors. The tables were skilfully arranged, securing convenience and comfort both to exhibitors and guests. By the side of each microscope was a card bearing the exhibitor's name, that of his instrument and of the object shown from 8 to 9 o'clock, and of another shown from 9 to 10 o'clock. Among so many instruments there was of course much variety, — almost every working model made in this country or in Europe had its representatives. It was certainly gratifying, to some at least, to notice that a majority of workers in this country are using the generous, handy models, of intermediate size, of American and English make.

It is safe to say that this grand exhibition has never been surpassed in this country. Has it in any other? This is said, and the query put — having in mind the number and character of the instruments, the nature and grade of the objects exhibited, and the manner in which they were shown. Another factor in the pleasure of the evening, so far as the societies were concerned, was the large and intelligent party who could see and appreciate the exhibitions. It is a noteworthy fact that many investigators exhibited specimens of their own best work. It may be invidious to mention special cases when there are so many worthy ones that must remain unnoticed; but, surely, no one who saw and became interested in the set of plates exhibited by Prof. Rogers, can question the propriety of special mention. The series of plates illustrated his paper read before the Society, on the action of a diamond in ruling lines on glass. The series, after illustrations are prepared for the proceedings, it is understood, are to be deposited with the Royal Microscopical Society. In a separate room, darkened for the purpose, L. D. McIntosh exhibited a variety of objects by means of his solar microscope and "ether oxygen light;"

in another similar apartment Col. A. E. Stevenson exhibited a variety of well prepared objects, by means of his projection microscope, made by Dr. Hugo Schröder, of Hamburg, and which is said to have the largest prism ever cut. The thanks of the societies are due to the Calumet Club for their courtesies, and especially to Mr. B. F. Nourse, chairman of the Committee on Soirée, for the very complete and happy arrangements and management of the affair.

During the course of the meeting several important reports were received. The committee on nomenclature and sizes of eye-pieces, R. H. Ward, chairman, rendered a report, in which it was recommended: 1. "That oculars, like objectives, be named by their equivalent focal length, in English inches." The report continues: "We believe this method to be the best adapted to practical use, sufficiently precise for its object, and capable of general introduction with less inconvenience, opposition or delay than any other rational system." 2. "We report in favor of adopting one or more standard sizes for the tubes of oculars . . . As an important step towards uniformity, we would gladly recommend the adoption of the sizes recently proposed by the Royal Microscopical Society, 0.92 and 1.35 inches, were they adapted to the conditions existing in this country. But .92 in. is a smaller size than we are willing to recommend for any purpose, being much too little, in our judgment, for even the small compact stands of the 'Continental' model. On the other hand we would have preferred 1.40 in. for the large tube, but do not regard the difference as sufficient importance to justify the naming of still another size. There remains, however, a very large variety of medium-sized stands, a class believed to be rapidly increasing in number and importance, which cannot, without total change of character, be raised to 1.35 in., and which should not, in our opinion, be reduced even to 1 in. We therefore propose a

standard medium size, 1.25 in., which we believe well adapted to a great majority of purposes, with the alternatives of 1 in. and 1.35 in. for those who wish a smaller or a larger size. . . . We would also recommend that 0.75 in. be made a standard for the upper tube of the ocular. We would also recommend the adoption of the diameter 1.50 in. recommended by the Royal Microscopical Society for substage tubes." The report will be printed in the Proceedings, and receive further consideration next year.

Prof. Rogers, who represents the Society in the general committee on Micrometry, Prof. Barnard, chairman, presented an exhaustive report upon "Standard Centimeter A, 1882," obtained from Prof. Hilgard, director of the United States Bureau of Weights and Measures. This particular plate is of platinum-iridium, united to brass by silver solder. It is now the property of the American Society of Microscopists; the National Committee on Micrometry having received it from the Bureau of Weights and Measures, in turn, tendered it to the Society; it was accepted and adopted as a basis of future studies and discussions in micrometry. It is now in the custody of Dr. Fell, and rules for its use and control will soon be published by the committee appointed for the purpose, and for securing copies on glass. Prof. Rogers said of the plate, "In the examination with a half-inch objective supplied with Tolle's opaque illuminator, it became at once apparent that the defining lines are of the most beautiful character. I do not think I ever succeeded in producing lines upon a metal surface quite equal to the lines upon this plate." The original basis of comparison with the micrometer is a meter upon copper, prepared for Prof. Rogers by Prof. Tresca, of the Conservatoire des Arts et Meters of Paris. The results of the comparison of the platinum-iridium centimeter and the one-hundredth of a meter traced on glass, and those relating to the comparison of the micro-

meter with the meters of the archives will appear in the Transactions.

In recognition of the courtesy of the Royal Microscopical Society in having honored the American society,

by making its President for the time, a Fellow *ex officio*, the President of the Royal Society was for the time made an honorary member of the American Society.

(To be Continued.)

Zeiss Spectro-Polarizer.

The instrument manufactured by Mr. Zeiss, under the above name is a modified form of the Spectro-Polarizing Microscope of Rollett, already described in these columns. It is represented in fig. 31. It is intended for the same purpose as the latter instrument, but it can be applied to an ordinary microscope as an accessory. The reader is referred to the preceding article, describing Rollett's instrument, for an account of the principles involved in the construction and use of this one.

It is intended for the study of the double refractive properties of microscopic objects. It is placed horizontally beneath the stage of the microscope, the light passing in through the polarizing prism (Prazmonoski's), at *Pc.*; through the slit *Sp.*; the collimating lens *C.*; the two prisms *P.P.*, and finally through an objective at *O.* to the object on the stage. Selenite plates are placed in the path of the rays at *G.*

The supplementary tube *sk.*, contains a scale, an image of which, when properly illuminated, is reflected into the field of view from the face of the prism, as shown by the dotted lines. This scale gives the wave-lengths of the lines in the spectrum. By means of various adjustments, the spectrum can be made to traverse the field in any direction. There is no doubt much greater dispersion can be obtained with the prisms in the Zeiss instrument, than the direct-vision prisms of the Rollett instrument will give.

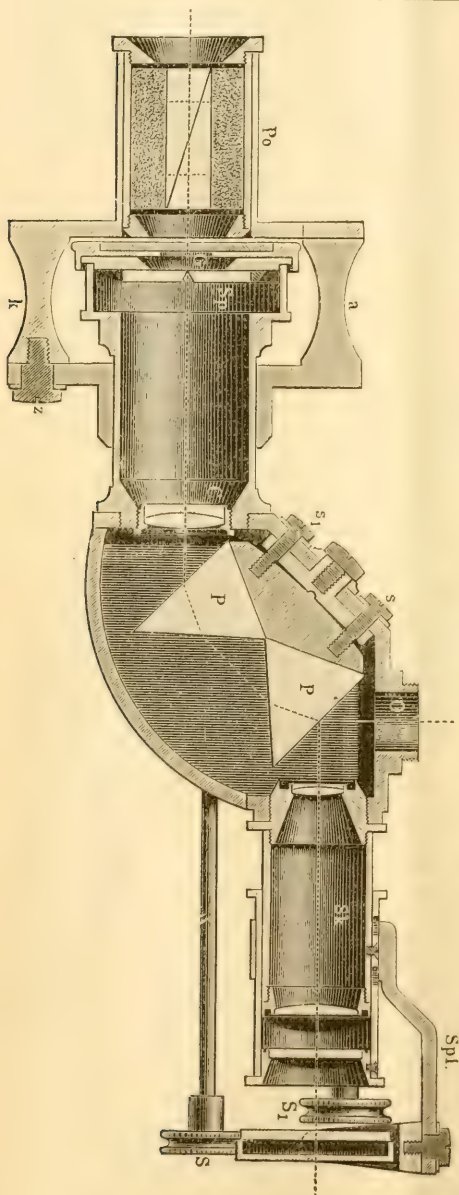


FIG. 31. — ZEISS SPECTRO-POLARIZER.

NOTICE.

TO SUBSCRIBERS:—The publishers of the JOURNAL regret to say that there are quite a number of subscriptions for the current year yet unpaid, and would respectfully request that all such be paid during the present month. If not paid before Sept. 15th, the subscriptions will cease.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

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MICROSCOPICAL EVIDENCE CONCERNING BLOOD CORPUSCLES.—From reports which have come to us through the newspapers, we have very meagre knowledge of the circumstances under which a gentleman, well-known to the readers of this JOURNAL, has testified in a recent trial, that certain spots found upon a coat were produced by human blood. The evidence given, as we have learned from the published reports, was of a nature to influence the result of the trial, and as it seems to have been of a very positive nature, we must presume that the attendant circumstances were such as to fully justify it; for, at the present time, it seems rash, to say the least, to venture very positive testimony founded upon measurements of blood corpuscles alone. In other words, if, in the case referred to, it were conclusively shown that the stains could not have been produced by the blood of some animal whose blood-cells are almost the same as those of man, then the microscopical evidence would be sufficient to prove the nature of the stain, and to distinguish the blood-cells from those of birds, etc. But, on the other hand,

we have grave doubts, which are shared by many microscopists of experience, if the shape and size of the cells of dried blood, obtained from woven fabrics by soaking in mercuric chloride, or in any other way, are sufficiently characteristic to justify any positive evidence of their origin, based upon our present knowledge and experience.

We do not express the opinion that it is impossible to distinguish the different kinds of corpuscles in this way. On the contrary, it seems very probable that it can be done. There seems to be great constancy in the average sizes of the corpuscles of different animals, and, providing a sufficient number of them are measured to get a fair average size, there is no doubt of our ability to distinguish different specimens of fresh blood with absolute certainty. But in dealing with dried blood, especially such as is dried upon cloth, or fibrous surfaces, the corpuscles are likely to be distorted, and it is more difficult to get a fair average by measurements. Moreover, the shrinkage of corpuscles in drying may be greater or less under different circumstances, and its amount is not yet known with any certainty. In any case it must be very slight, to be sure, but in a matter of such vital importance it cannot be neglected by the scientific observer, until its amount is known for all circumstances. Granting the strong probability that the microscope does, under favorable circumstances, afford a means of positively identifying human blood, and distinguishing it from all other blood, we must still hold to the opinion that, until experience has shown such evidence to be sure and infallible, no scientific man is warranted in stating that a stain upon cloth is made by human blood, from the microscopical examination alone.

Doubtless in the particular case referred to, the microscopist was fully justified in giving the positive testimony that has been reported, but we would particularly impress upon the reader

the uncertainty of the microscopical evidence taken alone—it may be justly maintained that such evidence is, to say the least, not infallible. The subject having been brought before the public once more, it seems desirable that microscopists should be reminded that the microscope cannot be regarded as infallible to distinguish human blood. It may be we are conservative about it. We are willing to believe that the microscope is capable of identifying human blood from the examination of a few dried corpuscles, but the proof that it is so, seems to us not conclusive. If we err it is upon the side of safety; and to those readers who have had no practical acquaintance with such examinations, we would say, do not be led into error by the apparent simplicity of the problem. If human blood can be identified with the microscope, it can only be done with safety by persons of great experience in the examination and measurement of blood-cells.

WE should be pleased to receive from a large number of our subscribers samples of the new "Postal Note;"—a note of the value of \$1.00 can be purchased for a 3c. stamp in addition to the dollar, and is a safe and convenient means of sending money.

SPIROGYRA.—In all specimens of this beautiful alga with longitudinal spiral bands of chlorophyl, a nucleus can be observed near the middle of the cells, and if a favorable view is obtained it will be seen that from the nucleus radiating and branching threads of colorless, minutely granular, protoplasmic matter extend in all directions. It has been supposed that these threads of protoplasm extended to the layer of protoplasm lining the walls of the cells, but Pringsheim has observed that this is not true. They pass to the inner surface of the chlorophyl-bands, and there end in a trumpet-like expansion which encloses

a granule of starch, or if there is no starch-grain to be seen at the spot, it may be expected to appear there very soon. The threads may divide and then two granules of starch will be formed where the branches reach the chlorophyl; or the starch-grains themselves may divide and separate, which will also cause a forking of the protoplasmic thread. In the latter case the two amyllum-bodies will be also connected by a lateral extension of the protoplasm forming a bridge between them.

We commend these observations to our readers as worthy of verification. *Spirogyra* is a beautiful plant to study and is easily obtained. It will grow for weeks in a saucer of water. We can freely say that whoever attempts to verify the work of Pringsheim described above, will find it no easy matter to make out even the terminations of the protoplasmic threads, but it is well worth the trial, as a good test for manipulative skill. We suggest it to those who have exhausted the charms of *Amphipleura*.

ERRATA.

Page 125 1st column, line 23, the word "part" should read "ounce."

NOTES.

— G. Volkins states that at the tip of the leaf of *Calla* there is a modified form of the stomata, which assists in the excretion of water by the leaf. The modified stomata are larger than the others, situated in the epidermis of the cylindrical apex of the leaf. The water is excreted by pressure from the root.

— J. C. Müller has made some curious observations on the action of a solution of 50 grains of pure caustic potash in an ounce of water upon living diatoms. The species experimented with was *Synedra radians*. Placing the moist diatoms on a slip and allowing them to get nearly dry, the solution was applied when in a few hours, the connective separated into two fine silicious films, one part belong-

ing to one valve and the other to the opposite valve. In 24 to 36 hours the striated portions broke up into fragments resembling the iron cramps of carpenters. "In fact, the striation is due to the juxtaposition of a number of these little cramps along the length of the frustule, probably cemented together originally."

—The latest type slide of Mr. J. D. Möller contains 1,600 arranged diatoms and is offered for sale at 1,600 marks—about \$370.00 at the lowest calculation. A plate with 800 and another with 400 diatoms are also made. All type slides are put up with monobromide of naphthaline, and test-objects from Mr. Möller may now be obtained mounted in balsam monobromide of naphthaline, or solution of phosphorus.

—Almost every year the young trout bred in the piscicultural basins of the *Collège de France* become attacked about July, by a malady that carries off great numbers of them. This is caused by a ciliated infusorian known as *Ichthyophthirius multifiliis*, which lives upon the epidermis and causes inflammation of the skin. There has lately been observed, by Mr. L. F. Henneguy, another parasitic infusorian which attacks the young fish almost as soon as they are hatched, and destroy great numbers of them. This parasite covers the epidermis in such numbers that the epidermal cells are quite concealed from view. Each infusorian has three flagella. The animals resemble Stein's *Bodo caudatus* in shape, and have been provisionally named *Bodo necator*. They measure 0.02 mm. in length by 0.01 mm. wide, and are the first ectoparasitic flagellata that have been described.—*Comptes Rendus*.

—A dead black color for brass is frequently desired by amateurs in making accessory apparatus, and we had had inquiries, from time to time, as to how it can be obtained. For the inside of tubes a good black is obtained by mixing fine lamp-black with ordinary lacquer, and applying it with heat. Only one or two thin coats should be applied, or the surface will become glossy. The lacquer used is merely a solution of shellac in alcohol. Many brass parts are blackened or bronzed by the application of a dilute solution of platinum chloride, which immediately gives a dark color to the metal. Corrosive sublimate dissolved in vinegar (about 30 grains to the ounce) will also give a bronze color. To get a good

black, a solution of copper wire in nitric acid will serve best of all, but the articles must be so highly heated that soldered joints will be loosened.

—It has been found, by M. E. Panchon, that the sound vibrations of the highest note audible to the human ear are 72,000 per minute. Mr. Galton has made a hydrogen whistle which is said to produce 312,000 sound vibrations per second. This whistle is 14 inches long by 0.04 inch in diameter. Such exceedingly rapid vibrations are quite inaudible to us, but the instrument has been devised to test the hearing power of insects, which is very acute. The results have not yet been published.

—Mr. A. D. Michael states that for mounting insects in balsam the creatures may be killed in hot water or spirit. He prefers to use hot water for hard insects and acari because it causes them to expand their legs. Minute flies are best killed in alcohol. In mounting he advises not to use quite enough balsam to fill the space under the cover, as the balsam supports the cover if it does not reach the edge, while if it extends to the edge it is apt to draw down the cover and crush delicate objects. He recommends thin glass beads to support the cover-glass. To mount hydrozoa, polyzoa, etc. with extended tentacles, he prefers to use alcohol for killing them in this way: The objects are placed in a watch-glass and left undisturbed until their tentacles are well-extended. A small drop of spirit is then run down the side of the glass but not on the polypes. The tentacles will then probably be withdrawn, but after a time they will be again extended. Add then another drop of spirit. After two or three repetitions of this operation the animal seems to get drunk, and then alcohol may be added freely.

—Dr. William B. Carpenter has presented to the United States National Museum a fine series of slides illustrating his monograph on the genus of foraminifera *Orbitolites*, which will be published as one of the reports of the "Challenger" expedition. Dr. Carpenter makes four species. *O. termissima*, a very delicate shell, specimens of which are difficult to obtain, *O. marginalis*, *O. duplex*, and *O. complanata*. There are 47 slides in the collection, illustrating the method of growth of the shells, and showing all the principal characteristics described in the report, which will be soon issued.

—The minute size and extremely virulent properties of some of the septic bacteria is surprising. The septic bacteria, or bacetria of putrefaction, are those which are found in the animal body after death. They are supposed to be quite distinct from the pathogenic bacteria. It is remarkable that some of the septic organisms seem to be confined in their effects to certain animals. Thus, Davaine's septicæmia in the rabbit is not dangerous to man, cattle, horses, sheep or dogs. Mr. G. F. Dowdeswell, M. A., has described a form occurring in the lung of a mouse infected with septicæmia, which he regards as the smallest known organism. It is a form of bacillus, the cells of which are about 0.001 mm. or $\frac{1}{250000}$ of an inch in length, by less than $\frac{1}{1000000}$ of an inch in breadth. In the case of the septicæmia of the rabbit, the number of organisms in the blood was estimated as upwards of 3,000 millions in a single drop; and probably a still larger number of these very minute bacteria would be found in the same quantity of blood containing them.

—Mr. J. Horn of Scarborough, England, has devised a method of mounting very minute animals, such as embryonic fishes for example, in a medium which makes them transparent, and causes but very little contraction of the internal parts. At present the composition of the fluid used is not made known, but probably it will be published before long.

—Mr. W. P. Collins, 157 Great Portland St., London, has just issued an advance edition of a catalogue of new and second-hand books and publications relating to microscopy. Mr. Collins is, we believe, the only dealer in scientific books in the world who gives special attention to works on the microscope, and in his new catalogue are mentioned numerous rare and valuable books now on hand. In order that persons in foreign lands may have an opportunity to obtain such books as they desire, a special edition of the catalogue will be sent to the United States and to other foreign countries a month sooner than the home-edition will be circulated. Among the special features of the catalogue may be mentioned: a list of important papers taken from journals, transactions of societies, etc., and bound separately in paper covers; a list of works, English and foreign, issued since 1881; an index to works on general microscopy and to special bran-

ches of microscopical literature. In October Mr. Collins proposes to begin the publication of a monthly list of general scientific works. Microscopists who desire to keep up with the literature relating to any branch of microscopical study, will find Mr. Collins's catalogues invaluable.

—One of our most prominent and widely known scientific exchanges, on reviewing a late work on Photo-Micrography, is of the opinion that *Micro-photography* is "a term more definite than the inverse of *photo-micrography* chosen by the author."

—We extract the following from a medical pamphlet by R. J. Nunn, M. D. of Savannah, Ga.

The Pillar Slide.—A new slide for the microscope.—Take a small thick cover-glass, and cement it on the center of the slide with Canada balsam, and let it harden thoroughly. To use it, a drop of the fluid to be examined is placed upon the pillar just described, a cover larger than the pillar is placed upon it, when it will be seen that the excess of fluid flows into the annular space surrounding the pillar. The advantages claimed for this slide are that it does away with the necessity for the use of a bibulant to absorb an excess of the fluids which is almost always present in the usual mode of examining them, and also that evaporation may take place for a considerable time from the annular space without affecting the film;—it is also very useful in making chemical tests.

—In the August issue of the *Kansas City Review of Science and Industry*. Mr. Wm. Dawson gives an interesting table of all the Eclipses of the Sun and Moon for the present century (1800 to 1900). During the first half of the century there were 199 eclipses and 196 to be in the second half, or 395 in all, there being 68 more to occur. The greatest number occurring in one "United States year," was six, but an eclipse of the sun occurred 1804, Dec. 31, 8 P.M. which was January 1st, 1 A.M., 1805, in England, and there being six eclipses after this one in that year, there were seven (the greatest number that can ever be in one year) in 1805, in the Eastern Hemisphere and only six in the Western. A similar occurrence took place four hours after New Year's Day, 1824, and as there were six eclipses in 1823, it was

still 1823 somewhere out in the Central Pacific when the eclipse occurred, so there 1823 could be credited with seven eclipses.

CORRESPONDENCE.

DIVISIONS OF MICROMETER EYE-PIECE.

TO THE EDITOR:—Will you kindly tell me what is the best way—in what parts of an inch—to have an eye-piece micrometer ruled? I shall want to use it not only to measure objects microscopically large, but objects that are at the other extreme and are microscopically minute. I find nothing in the books in my possession to help, except your own article "How to measure," in the AMERICAN MONTHLY MICROSCOPICAL JOURNAL. You there say the lines may be about $\frac{1}{100}$ -th inch apart. Isn't that space pretty large for minute objects?

[The above letter was not sent for publication, but the question presented is of such general interest that we have decided to answer it in the JOURNAL for the benefit of other subscribers as well as the writer.]

In the first place, the reader must understand that the exact distance between the lines is a matter of no consequence. When we speak of $\frac{1}{100}$ of an inch as a convenient spacing, it is not necessary that the lines should be precisely $\frac{1}{100}$ of an inch apart. It is only necessary that they be perfectly spaced, whether the unit be $\frac{1}{100}$, $\frac{1}{120}$, or $\frac{1}{90}$ of an inch. The value of the divisions is given in terms of a standard stage-micrometer, and has no reference whatever to the proportion that may exist between the spaces and an inch or centimetre on a common rule. To illustrate this, suppose we place a ruled eye-piece micrometer in place and put a stage-micrometer ruled in hundredths of an inch on the stage, using $\frac{2}{3}$ -inch objective. The image of the stage-micrometer is seen in conjunction with the lines in the ocular. As the draw-tube is moved out or in the image of the stage-micrometer grows larger or smaller, while the distance between the eye-piece lines remains unchanged. In one position each division in the ocular may equal eight of the stage-micrometer, in another position, nine. In the one case it represents $\frac{8}{100}$ of an inch, in the other $\frac{9}{100}$. It has, therefore, no constant

value except for a certain objective with a stated length of draw-tube.

As regards the best spacing for an eye-piece micrometer, it is clear that the value of the divisions changes with the objectives. As the power of the latter is increased, the value of each space in the eye-piece scale becomes less, and when very low-powers are used the value of the divisions increases accordingly. Consequently, it will be found, in practice, that the best division for one power will answer very well for any other power. We are referring now to eye-piece micrometers of the ordinary kind—plain lines ruled on glass, every fifth and tenth line longer than the others. It might be assumed that very close lines would be desirable to accurately measure extremely minute objects, and much more widely spaced ones for larger objects. But in practice it will be found that when lines are quite close together in the ocular they are confusing to count, and they obscure the view, so that more accurate measurements may be made with lines more widely separated, leaving the more minute division to be estimated. On the other hand, when the lines are too far apart the fractions of the divisions cannot be so accurately estimated. On the whole, therefore, it seems best to adopt some division which shall give sufficient accuracy without confusing the mind in counting the lines, or in any wise obscuring the view of the object. It is on these grounds that we have ventured to recommend the spacing of $\frac{1}{100}$ of an inch.

It should be remembered that the eye-lens of the ocular magnifies the eye-piece scale, and the apparent distance between the lines will vary with the power of the eye-lenses of different oculars. It is the apparent size of the scale that concerns us in this matter, more than the actual spacing. We prefer to use the scale in the "B" ocular, making it a permanent fixture in the ocular.—Ed.]

DIATOMS IN BARBADOES DEPOSIT.

TO THE EDITOR.—Some time in June I received from a correspondent a small vial of a new Find of Barbados polycystina, which when I came to mount, I found to contain what to me was a new form of diatom, and I mounted three valves and sent them to Mr. Chas. Stodder who answers, as follows: The slide No. 3 is a curious mutation-variation of the *coscinodiscus*; never saw the

like — never saw or read of any thing like it. The slide of the material appears just like some of the Barbadoes deposits, broken polycystina Radiolaria with a few diatoms, very rare and peculiar, also like some St. Monica, Cal., samples.

THOS. CHRISTIAN.

Richmond, Va.

NOTICES OF BOOKS.

A Report upon Cereals, and the products and accessories of Flour and Bread-Foods; Baking powders; Cream Tartars; Bicarbonate of Soda; Bicarbonate of Ammonia; Alum Powders and the "Alum Question." By. E. G. Love, Ph. D. School of Mines, Columbia College. Reprinted from the second annual report State Board of Health of New York. (Pamphlet. pp. 30. Illustrated.)

Bulletin of the Museum of Comparative Zoology, at Harvard College. Vol. VII.—No. IX. On the Relations of the Triassic Traps and Sandstones of the Eastern United States. No. X. The Folded Helderberg Limestones east of the Catskills. By William Morris Davis. Cambridge. Printed for the Museum, 1883.

Bulletin of the Museum of Comparative Zoology at Harvard College. Vol. XI. Nos. 1 and 2.—Reports on the results of dredging, under the supervision of Alexander Agassiz, on the east coast of the United States, during the summer of 1880, by the Coast Survey Steamer "Blake," Commander J. R. Bartlett, U. S. N. Commanding.—Published by permission of Carlile P. Patterson and J. E. Hilgard, Supts. U. S. Coast and Geodetic Survey.

Chapter XXI. Report on the Anthozoa, and on some additional species dredged by the "Blake" in 1877-79, and by the U. S. Fish Commission Steamer "Fish Hawk" in 1880-82. By A. E. Verrill.

Chapter XXII. A chapter on the History of the Gulf Stream. By Alexander Agassiz. Cambridge: Printed for the Museum. 1883.

Report on the Area of Corn, Potatoes, and Tobacco, and the Condition of Growing

Crops in the United States and Europe. Department of Agriculture, Washington. Government Printing Office, 1883.

One of the valuable reports periodically issued by the Department of Agriculture, giving the results of careful investigation of the crops in all parts of the U. S. as well as the results of experiments with various species of cereals in different places, Manures, etc, and recording the Meteorological changes and conditions.

Observations on the Soil and Products of Florida. By Wm. Saunders. Superintendent of Gardens and grounds, etc. *The Grasses of the United States, being a Synopsis of the Tribes and Genera with Descriptions of the Genera and a List of the species.* Prepared by Dr. Geo. Vasey, Botanist to the Department of Agriculture.

Report on the Condition of Crops. "American Competition" and Freight rates of transportation Companies. August, 1883.

Special Reports, Nos. 62, 63 and 64 of the Department of Agriculture. Washington Government Print. 1883.

Exchanges.

FOR EXCHANGE.—Slides of pollen of pitch pine, *Pinus rigida*, with the connection stained, for any named slides of algae. Dr. C. F. Millsbaugh, E. M. S., Binghamton, N. Y.

WANTED.—*Trichina Spiralis*, *Pleurosigma* Ang., or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

FOR EXCHANGE.—Well-mounted double-stained vegetable preparations, also, a few first-class injected preparations for other well-mounted slides. N. A. Richards, St. Louis, Mich.

WELL-MOUNTED slides of Polycystina, transparent and opaque, for any well-mounted slide. P. C. Cole, M. D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 108 Virginia St., Richmond, Va.

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NO. 10.

Abbe's Method of Testing Objectives.

[The following article, by the late Dr. H. E. Fripp, was published in the *Proceedings* of the Bristol Naturalists' Society, in the year 1877, and has been reprinted in the *Journal* of the Royal Microscopical Society. It is of such general interest that we copy it from the last mentioned *Journal*, in full. — ED.] In ordinary practice, microscope objectives, if tested at all by their possessors, are simply subjected to a comparison of performance with other lenses tried upon the same "test objects." The relative excellence of the image seen through each lens may, however, depend in a great part upon fortunate illumination, and not a little upon the experience and manipulative skill of the observer; besides which any trustworthy estimate of the performance of the lens under examination, involves the consideration of a suitable test object, as well as the magnifying power and aperture of the objective. The structure of the test object should be well known, and the value of its "markings," if intended to indicate microscopical dimensions, should be accurately ascertained, care being taken that the minuteness of dimensions and general delicacy and perfection of the test object should be adapted to the power of the lens. A fairly correct estimate of the relative performance of lenses of moderate magnifying power may doubtless be thus made by a competent observer, but it is not possible from any comparisons of this kind to determine what may, or ought to be, the ultimate limit of optical

performance, or whether any particular lens under examination has actually reached this limit.

Assuming the manipulation of the instrument and the illumination of the object to be as perfect as possible, and, further, that the test object has been selected with due appreciation of the requirements of perfect optical delineation, a fair comparison can only be drawn between objectives of the same magnifying power and aperture. Which of two or more objectives gives the better image may be readily enough ascertained by such comparison, but the values thus ascertained hold good only for the particular class of objects examined. The best performance realized with a given magnifying power may possibly exceed expectation, yet still be below what might, and therefore ought to be, obtained. On the other hand, extravagant expectations may induce a belief in performances which cannot be realized. The employment of the test objects most in use is, moreover, calculated to lead to an entirely one-sided estimation of the actual working power of an objective, as, for example, when "resolving power" is estimated by its extreme limits rather than by its general efficiency; or "defining power" by extent of amplification rather than by clearness of outline. So that an observer is tempted to affirm that he can discern through his pet lens what no eye can see or lens show. This happens chiefly with the inexperienced beginner, but not unfrequently also with the advocate of extremely high powers, in whose mind separation of detail means analysis of structure,

and optically void interspaces prove the non-existence of anything which he does not see.

As much time is often lost by frequent repetition of those competitive examinations (which after all lead to no better results than that the observer finds or fancies that one lens performs in his hands more or less satisfactorily than some other lens), it seems worth while to invite attention to a mode of testing which can be readily practised by any person, with a fair certainty of being able to form a really correct estimate of the working capacity of his instrument, measuring this by a standard of strict optical requirements. The advantage of substituting some such proceeding for the comparative trial of lens against lens, so long in vogue, can scarcely be disputed. For although the best warrant of a well-constructed lens is the fair reputation of its maker, and the choice of an objective resolves itself for the most part into the selection of the particular make of one or other of the best accredited opticians, still, when the instrument is purchased, its possessor frequently becomes haunted by the desire to pit its performance against that of some neighbor's instrument, or to match the performances traditionally accepted in our handbooks. A short and easy method of testing an objective, not by comparison with others only, but by itself and on its own merits, affords not only the most direct and positive evidence of its qualities to those who are more concerned in proving their instruments than using them, but also yields to the genuine worker the satisfying conviction that his labor is not frustrated by faulty construction and performance of his instrument. It is, however, to be borne in mind that the microscopist, in any scrutiny of the quality of his lenses which he may attempt, has no other object in view than to acquire such insight into the optical conditions of good performance as will enable him to make the best use of his instrument, and

acquire confidence in his interpretation of what he sees, as well as manipulative skill in examining microscopical objects. To the constructor and expert of optical science are left the severer investigations of optical effects and causes, the difficulties of technical construction, the invention of new lens-combinations, and the numerous methods of testing their labors by delicate and exhaustive processes which require special aptitude, and lie entirely outside the sphere of the microscopist's usual work.

The mode of testing the optical power of an objective here described, is that devised by Prof. Abbé, and explained in his "*Beiträge zur Theorie des Mikroskops.*"

The process is based on the following principle :—

In any combination of lenses of which an objective is composed, the geometrical delineations of the image of any object will be more or less complete and accurate, according as pencils of light coming from the object are more or less perfectly focussed on the conjugate focal plane of the objective. On this depend fine definition and exact distribution of light and shade. The accuracy of this focussing function will be best ascertained by analysing the course of isolated pencils directed upon different parts, or zones, of the aperture, and observing the union of the several images in the focal plane. For this purpose it is necessary to bring under view the collective action of each part of the aperture, central or peripheral, while at the same time the image, which each part singly and separately forms, must be distinguishable and capable of comparison with the other images.

1. The Illumination must therefore be so regulated that each zone of the aperture shall be represented by an image formed in the upper focal plane of the objective (i. e. close behind or above its back lens), so that only one narrow track of light be allowed to pass for each zone, the tracts

representing the several zones being kept as far as possible apart from each other. Thus, supposing the working surface of the front lens of an objective to be $\frac{1}{4}$ inch in diameter, the image of the pencil of light let in should not occupy a larger space than $\frac{1}{16}$ inch. When two pencils are employed, one of these should fall so as to extend from the centre of the field to $\frac{1}{16}$ inch outside of it; and the other should fall on the opposite side of the axis, in the outer periphery of the field, leaving thus a space of $\frac{1}{16}$ inch clear between its own inner margin and the centre of the field, as in fig. 32, where the objective images



FIG. 32.

of the pencils occupy each a quarter of the diameter of the whole field.

If these pencils of light be employed, the first should fall so as to extend from the centre of the field to $\frac{1}{32}$ inch outside of it; the second should occupy a zone on the opposite side of it, between the $\frac{1}{32}$ and $\frac{1}{16}$ inch (measured from the centre), and the third, the peripheral zone on the same side as the first, as in fig. 33.



FIG. 33

This arrangement places the pencils of light in their most sensitive position, and exposes most vividly any existing defect in correction, since the course of the rays is such that the pencils meet in the focal plane of the image at the widest possible angle. As many distinct images will be perceived as there may be zones or portions of the front face of the objective put in operation by separate pencils of light. If the objective be perfect all these images should blend with one setting of focus into a single clear, colorless picture. Such a fusion of images into one, is, however, prevented

by faults of the image-forming process, which, so far as they arise from spherical aberration, do not allow this coincidence of several images from different parts of the field to take place at the same time, and so far as they arise from dispersion of color, produce colored fringes on the edges bordering the dark and light lines of the test object, and the edges of each separate image, as also of the corresponding coincident images in other parts of the field. It is to be borne in mind that the errors which are apparent with two or three such pencils of light, must necessarily be multiplied when the whole area of an objective of faulty construction is in action.

2. *The means by which such isolated pencils can be obtained.* If a special illuminating apparatus be employed, the condenser of Professor Abbé will be found very convenient, but almost any condenser of the kind (hemispherical lens) may be arranged for this purpose.

In the lower focal plane of the illuminating lens must be fitted diaphragms (easily made of blackened cardboard) pierced with two or three openings of such a size that their images, as formed by the objective, may occupy a fourth or sixth part of the diameter of the whole aperture, (*i. e.* of the field seen when looking down the tube of the instrument, after removing the ocular, upon the objective image). The required size of these holes, which depends, firstly on the focal length of the illuminating lens, and secondly, on the aperture of the objective, may be thus found. A test object being first sharply focussed, card diaphragms having holes of various sizes (two or three of the same size in each card) must be tried until one size is found, the image of which in the posterior focal plane of the objective shall be about a fourth to a sixth part of the diameter of the field of the objective. Holes having the dimensions thus experimentally found to give the required size of image

must then be pierced in a card, in such position as will produce images situate in the field as shown by figs. 32 and 33, and the card is then fixed in its proper place below the condenser. If the condenser be fitted so as to revolve round the axis of the instrument and also carry with it the ring or tube to which the card diaphragm is fixed, the pencils of light admitted through the holes, will, by simply turning the condenser around, sweep the face of the lens in as many zones as there are holes. Supposing the condenser to be carried on a rotating substage, no additional arrangement is required besides the diaphragm carrier. Thus, for example, if a Collins' condenser fitting in a rotating substage be used, all that is required is to substitute for the diaphragm which carries the stops and apertures as arranged by the

light admitted through the holes (which form images of these holes in the upper focal plane of the objective) are made to traverse the field of view and by rotating the substage the whole face of the lens is swept and thus searched in any direction required.

When an instrument is not provided with a rotating substage it is sufficient to mount the condenser on a piece of tubing, which may slide in, the setting always provided for the diaphragm on the under side of the stage. Card-diaphragms for experiment may be placed upon the top of a third piece of tube (open at both ends) made to slide inside that which carries the condenser, and removable at will. By rotating this inner tube the pencils of light will be made to sweep around in the field, and thus permit



FIG. 34.



35.

maker, a diaphragm pierced with say three openings of $\frac{3}{4}$ inch diameter, in which circles of card may be dropped, the card being pierced with holes of different sizes according to the directions given above.

Another plan adopted by Dr. Fripp and found very convenient in practice is to mount a condensing lens (Professor Abbe's in this case) upon a short piece of tube which fits in the rotating substage. On opposite sides of this tube, and at a distance from the lower lens equal to the focal distance of the combinations, slits are cut out, through which a slip of stout cardboard can be passed across and below the lens. In the cardboard, holes of various sizes, and at various distances from each other, may be pierced according to pleasure. By simply passing the slip through the tube, the pencils of

each part of the central or peripheral zones to be brought into play.

3. Test object. For this a prepared plate is required which shall present sharply defined black and white strips, opaque and clear lines alternating at close intervals, and lying absolutely in the same plane, so that no deviation can occur in the course of pencils of light transmitted through it. A test plate sufficiently perfect for all practical purposes may be made by ruling groups of lines, coarse and fine, with the aid of a dividing machine on a metallic film of silver or gold of infinite thinness, and fixed by known methods on glass. Cover-glasses of various thickness, from 0.24 mm. to 0.09 mm. (accurately measured), are ruled on one surface thus coated with a film of metal, the groups of lines varying from $\frac{1}{250}$ to $\frac{1}{1250}$ inch; the ruled

side is then cemented with balsam on a polished glass slip, several such prepared glasses being cemented side by side on the same slip, presenting the appearance shown in figure 34 (natural size), fig. 35 being one of the circles enlarged.

A perfectly corrected objective, tested with the test object, and by the mode of illumination above described, ought to show over the middle of the field a clearly defined image of the groups of lines under examination without any alteration of focus, and the colored borders of the separate partial images should not show any other tints than a very narrow edging of pure green, rose, or violet of the secondary colors of a spectrum. Spherical aberration is revealed, when, with the best focussing, the clear lines appear as if immersed in the middle of a broader foggy streak, or when two images, more or less overlapping each other, merge on altering the focus, into one image, somewhat broader and more misty.

A short and ready method of testing approximately any objective is recommended by Professor Abbé, as it is applicable to all instruments without requiring any apparatus except the test object already described. This may be briefly explained as follows:—

First focus the test plate with central illuminating rays; then withdraw the eye-piece, and turn aside the mirror so as to give the utmost obliquity of illumination which the objective under trial will admit of. This will be best determined by looking down the tube of the microscope whilst moving the mirror, and observing when the elliptic image of light reflected from it reaches the peripheral edge of the field. As soon as this is done, replace the eye-piece and examine afresh the object plate without altering the focus. If the objective be perfectly corrected, the groups of lines will be seen with as sharply defined edges as before, and the colors of the edges must, as before, appear only as those of the secondary

spectrum in narrow and pure outline. Defective correction is revealed when this sharp definition fails, and the lines appear misty and overspread with color, or when an alteration of focus is necessary to get better definition, and colors confuse the images.

A test image of this kind at once lays bare in all particulars the whole state of correction of the microscope; it being of course assumed that the observer knows how to observe and what to look for.

With the aid which theory offers to the diagnosis of the various aberrations, a comparison of the colored borders of the separate partial images, and an examination of their lateral separation and their differences of level, as well in the middle as in the peripheral zones of the entire field, suffices for an accurate definition of the nature and amount of the several errors of correction, each of them appearing in its own primary form. Therewith we also see that which arises from aberration, properly so called (faults of focussing function), clearly separated from such imperfections or anomalies as spring from mere differences of amplification between unequally refracted rays; and moreover we eliminate completely all influence of the ocular on the quality of the image.

The American Society of Microscopists.

Continued from page 174.

The space at command does not warrant an analysis and abstract of all the papers read. The greater part are mentioned below.

Dr. F. M. Hamlin read the first paper, title, "The Microscopical Examination of Seminal Stains." He had found by experiments upon stains known to be seminal, that the method of Dr. Koblanck was not satisfactory. This method, with its soaking and manipulation, tends to destroy so many of the spermatozoa as to lessen

greatly the certainty of finding them. As the result of many experiments the author recommended the following methods:

"1. If the stain to be examined is upon any thin cotton, linen, silk, or woolen fabric, cut out a piece about one-eighth inch square, lay it upon a slide previously moistened with a drop of water, and let it soak for half an hour or so, renewing the water from time to time as it evaporates. Then with a pair of needles unravel or fray out the threads at the corners, put on the glass cover, press it down firmly, and submit to the microscope."

"2. If the fabric is of such a thickness or nature that it cannot be examined as above, fold it through the center of the stain, and with a sharp knife shave off the projecting edge thus made, catching upon a slide moistened with water the particles removed. After soaking a few minutes—say five to ten—the powdery mass will sink down through the water and rest upon the slide. The cover glass may now be put on and the preparation examined."

A paper on College Microscopical Societies, by Prof. Sarah F. Whiting, pointed out the usefulness and the means for sustaining such societies. The microscope is used in a very wide range of departments of research; each year the incoming class introduces those having no particular bent, those who have been occupied for years with the dry drill of mathematics and language; the Microscopical Society welcomes the fresh men, and its work and exhibitions stimulates them to scientific studies, and opens their eyes to the perfections of nature; they encourage research outside the branches of college instruction. The necessary conditions of success are pretty much the same as in other societies: there must be workers, opportunities such as time, books and apparatus, and above all persistent, painstaking work and forethought on the part of living instructors.

A very practical paper, by Prof. T. H. Gage, treated the subject of Catalogising, Labeling, and Storing Microscopical Preparations. The author said, "To the investigator his specimens are the most precious of his possessions, for they contain the facts which he tries to interpret, and they remain the same while his knowledge, and hence his power of interpretation increases. They thus form the basis of further or more perfect knowledge; but in order to be safe guides for the student, teacher or investigator, every preparation should possess two things, viz.: a label and a catalogue or history. The label should indicate all that is known of the specimen at the time of its preparation, and all of the processes by which it was treated." The card form of catalogue was recommended. "The cards are postal-card size, and each preparation has its own card. The cards may be kept in a neat box, alphabetically arranged, the cards of new preparations may be added, and those of discarded ones removed without marring the catalogue." The cabinet should possess the following characters: 1. Allow the slides to be flat, dust and light excluded. 2. Each slide should be in a separate compartment, each end of which should be grooved, or labeled to facilitate removal of the slide. 3. Each compartment should be numbered to agree with that of the slide. 4. The drawers should be independent, but run so close that when tipped the slides are not displaced; the drawers should be numbered also.

President McCalla's annual address was delivered on the evening of Tuesday, in Weber Music Hall, before a good audience of citizens and members of the society. He announced as his theme the "Verification of Microscopical Observation." The discourse was an able one, showing a wide range of reading and accurate knowledge in many branches. The common bond in the national society he defined thus: "We are not all

botanists, nor all zoölogists, nor all students of lithology, yet we have a well defined common ground. We are all deeply interested in the physics of the microscope, and in the methods of its use, and in order to be skillful in that department of investigation that we have severally chosen, we must be, more or less, fully practical in microscopic work in many other fields." After showing the necessity for verification, the several methods were discussed under the following heads: repetition of observation, the use of the camera lucida, photomicrography, media and re-agents, improved lenses and accessories, and a better knowledge of optics. In closing the address he said, "Let us resolve to use this wonderful agent of investigation more earnestly, with greater carefulness against error and reverence for the truth, and so seek more and more to know things as they are, and as we shall know them some day, I trust, when we shall no longer see through a glass, darkly; but shall know even as we are known."

The forenoon session of Wednesday was mostly occupied with reading and discussing papers on Bacteria. Prof. T. J. Burrill gave at length *Methods for Preparing and Mounting Bacteria*. Dr. H. J. Detmers presented a discourse upon *Pathogenic Bacteria*, followed by one by Dr. Geo. E. Fell, on the *Clinical Effects of Ozone on the Micro-organisms of Infusions*. It is impossible to give the gist of these papers in a few words. The animated and learned discussions which followed, demonstrated the value of the papers, and the fact that our investigators are awake to the importance of a knowledge of these forms.

The first paper of the afternoon session was a masterly discussion of the *Action of a Diamond in Ruling Lines on Glass*. At the outset the author paid this high compliment to a contemporary: "In offering this communication upon the subject indicated

by the title of this paper, I am not unmindful of the fact that I enter a field in which I acknowledge a master. Since the death of the incomparable Nobert, Mr. Fasoldt of Albany stands easily first in the art of fine ruling. . . . I have thought it better to confine my attention to another equally important problem, viz.: an attempt to obtain correct copies of the Imperial Yard and Meter des Archives, at the temperature at which they are standard, to sub-divide these units into aliquot parts, and thus to obtain a microscopic unit whose sub-divisions should be so nearly equal that the microscope would fail to reveal the difference. The first part of this work has been nearly completed. . . . The sub-division of these units into aliquot parts—the yard into inches and the meter into centimeters—has been so far completed that any errors which may remain will not effect the microscopical unit sought. With regard to the exact subdivision of the latter unit, I can only report progress." The author's theory regarding the method which Nobert may possibly have employed in the production of his test-plate was briefly stated thus: "When a diamond is ground to a knife edge, this edge is still made of separate crystals, though we may not be able to see them, and a perfect line is obtained only when the ruling is done by a single crystal. When a good knife-edge has been obtained, the preparation for ruling consists in finding a good crystal." . . . "When a diamond has been so adjusted as to yield lines of the best character, its ruling qualities improve with use. If Nobert had any so-called secret, I believe this to have been its substance."

The problem of fine ruling consists of two parts,—"first, in tracing of varying degrees of fineness; and second, in making the interlinear spaces equal. The latter part of the problem is purely mechanical, and presents no difficulties which cannot be overcome by mechanical skill." The most marked characteristics of lines of

good quality ruled on glass were stated thus: "A perfect line is densely black, with at least one edge sharply defined. Both edges are perfectly smooth; add to these characteristics a rich, black gloss, and you have a picture of the coarser lines of a perfect Nobert plate. In the study of the action of a diamond in producing a breaking fracture in glass, the microscope seems to be of little service, but we can call it to our aid in the study of its action in ruling smooth lines. One would naturally suppose that a line of the best quality would be produced by the stoppage of the light under which it is viewed by the opaque groove which is cut by the ruling diamond. Without doubt this is the way in which lines are generally formed. But it is not the only way in which they can be produced. An examination under the microscope will reveal the fact, that in some instances at least, a portion of the glass is actually removed from the groove cut by the diamond; and that the minute particles of glass thus removed are sometimes laid up in windrows beside the ruled line, as a plow turns up a furrow of soil . . . The particles of glass removed take one of four characteristic forms: (a) They appear as chips scattered over the surface of the glass. (b) They appear as particles so minute that when laid upon a windrow and forming an apparent line they cannot be separated under the microscope. (c) They take the form of filaments when the glass is sufficiently tough for them to be maintained unbroken. (d) They take a circular form. . . . It must not, however, be supposed that lines of the best quality always present the appearance described above."

Mr. Fasoldt's claim that he has succeeded in ruling one million lines to the inch received attention. Concerning it Prof. Rogers said; "It is only fair to say that until recently I have shared in the general incredulity with which Mr. Fasoldt's claim has been regarded. Indeed, I still think he has placed the limit just a trifle

too high. But if the limit is reduced one-half, I am by no means sure but that it may be reached." After a discussion of the subject of the resolution of lines, this test was proposed: "Let us then have a test which will forever set at rest this vexed question of resolution. I submit for your consideration the following outline of a test which I venture to think will be sufficient and conclusive: Let Mr. Fasoldt rule three plates under as nearly the same conditions as possible, except in the number of lines in the different bands of each plate. Let him label each plate and accompany it with a full description of the number of lines in each band. Let these plates be sent to any gentleman in whom the great body of microscopists have confidence as eminently qualified to conduct an investigation of this sort, such as Prof. H. L. Smith of Geneva, or Col. J. J. Woodward of Washington. Let whoever receives the plates remove the labels of Mr. Fasoldt and put in their place labels whose signification is known only to himself. Then let the gentlemen who think they have resolved 152,000 lines to the inch take the plates, make their count of the lines in each band, and send in their report. Let the plates also be photographed, and let the number of lines be counted: then let the results of these investigations be published. If all substantially agree in the count, this will end further discussion."

Prof. A. H. Chester explained at length his new method of dry mounting with the cover-glass removable. "The object is fastened to the glass slip in the usual way and a cell built up around it by means of one or more tin rings. When the cell is high enough so that the cover-glass laid on top will not touch the object, a tin ring having a little larger hole is cemented on, thus forming a ledge on which the cover-glass may rest, with room above it for the wire ring which holds it in so firmly that there is no danger of its being jarred out." The

upper ring, having been cut with a gun-wad punch, has a bevel on the inside, and being set with the smaller hole uppermost, the bevel helps to hold the brass ring in place. This plan has many advantages, — the object may be examined uncovered, there is no trouble from running in, etc.

D. S. Kellicott gave an account of several species of vorticellidæ found upon the cray-fish. Two species were described as new, viz.: *Cothurnia variabilis* and *Epistylis Niagarae*. The former is peculiar to the gill-cavities, and is often so abundant that its habitat is colored brown, and possibly they cause asphyxia in the host. A notable peculiarity of the species is the fact that chains of loricae are often found, which appear to result from increase by division, the "new" animal compelled to leave the shell in which it was separated fastens to the outside of it and gets one of its own; this may be repeated indefinitely, — six in a chain is not uncommon. The *Epistylis* appears to be nearer to *E. balanæum* than to any other species. In other short papers the same writer described *Cothurnia lata* found on a species of *Diaptimus*, and gave an account of two internal parasites of the cray-fish.

Mr. W. H. Walmsley presented a paper on Photo-Micrography, giving the results of his own researches and those of others, to date, in this important branch.

Dr. A. M. Bleile and Adolph Friel jointly presented a paper on the Effects of Division of the Vagi on the Muscles of the Heart. The same investigators presented last year a paper having for its object the demonstration of nutritive or trophic nerves for the heart. By request of the society they continued their studies and reported the results. This time experiments were mainly upon pigeons; some of their conclusions are as follows: The fibres of the pigeon are more delicate and more friable than in the rabbit; in young pigeons the cross-

striation of the muscular fibres of the heart is indicated by the fine granules which might be mistaken for beginning degeneration, after the division of the one vagus, only there follows in the heart muscle of the pigeon a finely fatty degeneration about equally marked on both sides; after double vagotomy the degeneration is more marked.

Dr. Thad. S. Up de Graff read a paper on certain worms. He described a new rotifer *Brachionus Gleasonii*. One peculiarity is the possession of a dorsal horn or spine. "The lorica is in form an oblong square with two transverse angles posteriorly, acutely truncate in the dorsal aspect. From the four acute angles thus formed, project with a slight inward curve, four spines of nearly equal length and attenuated at the free extremities. The anterior margin of the shell is spineless." The length of the lorica, independent of the spines is 1-145 inch: found in stagnant water.

Dr. Christopher Johnson exhibited some new polarizing crystals, a description of which may be published in the AMERICAN MONTHLY MICROSCOPICAL JOURNAL.

Rev. Francis Wolle's short paper on Fresh-water Algae was read, also one by Mr. J. Kruttschnitt, on Ferns and their Development.

A paper which called forth considerable discussion, much of which was friendly, was read by Dr. Geo. E. Blackham, On the Relations of Aperture to Amplification in the Selection of a Series of Microscopic Objectives. The author's reasoning we cannot condense; his conclusions are as follows: "I have selected as a set of powers sufficient for all the work of any microscopist:

One 4-inch objective of .10 n. a. = 12° angle, nearly.

One 1-inch objective of .26 n. a. = 30° angle, nearly.

One ½-inch objective of .94 n. a. = 140° angle, nearly.

One ⅓-inch objective of 1.42 n. a.

The first two to be dry-working ob-

jectives without cover correction; the third to be dry working, with cover correction, and the fourth to be a homogeneous immersion objective with cover correction, and all to be of the highest possible grade of workmanship. The stand should have a tube of such length that the standard distance of two inches from the front surface of objective to diaphragm of eye-piece can be obtained on it, and be furnished with six eye-pieces, viz.: two-inch, one-inch and three-fourth inch Huyghenian, and one-half, one-third, and one-fourth inch solid."

Important papers were presented by Dr. Thomas Taylor and Dr. M. L. Holbrook. The former on Some Internal Parasites of the Domestic Fowl, the latter on the Terminations of the Nerves in the Kidneys.

Prof. J. M. Mansfield also discussed Division of Labor Among Microscopists; Dr. L. M. Eastman, Some Egg-like Bodies in the Liver of the Rabbit, and Dr. S. Hudson, Torula (*Saccharomyces*) *Cerevisiae*. He had found it a never-failing test for diabetic urine.

Dr. V. S. Clevenger gave a discourse on the Pathology of the Brain.

Several modified or new pieces of apparatus were described.

Gov. Cox described his new Microscope with concentric movements; D. L. McIntosh his Solar Microscope and Stereopticon, with ether-oxygen light attachment.

The following manufacturers and dealers were present and exhibited examples of the latest and best microscopes and accessories:—

W. H. Walmsley, Philadelphia, Pa.
Jas. W. Queen & Co. " "
Edward Bausch, Rochester, N. Y.
L. R. Sexton, " "
W. H. Bulloch, Chicago, Ill.
L. D. McIntosh. " "

Baker's Seaside Microscope.

Mr. Thomas Curties has favored us with the illustration given herewith of the seaside microscope, made by Messrs. C. Baker & Co., of London

(fig. 36). We have used this microscope from time to time during our stay in London, and have been so much pleased with its convenience, solidity

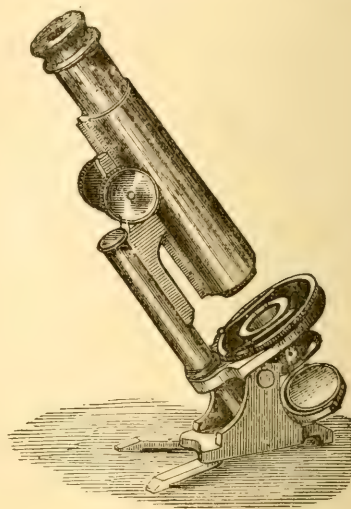


FIG. 36. — BAKER'S SEASIDE MICROSCOPE.

and lightness that we are pleased to recommend it to persons who desire such an instrument for observations in the country or at the seaside.

The merit of this instrument is not that it packs into a very small compass, for, on the contrary, the box that encloses it is rather large as compared with the cases of many of the travelling microscopes now to be obtained. It is, however, not inconveniently large, and is very light. It is capacious enough to hold the necessary accessories for ordinary observations in the country.

The stand itself is very firm, and in this respect fully equal to larger and more costly instruments. A fault with many of the traveling microscopes, is that they are so complicated as to be troublesome to set up, while at the same time they are costly by reason of their complexity, and it may be added, they are often inconveniently small for use. This microscope is ready for use at any moment. It has only to be taken out of its case, and

the feet of the base spread out, when it is complete. The figure renders further description unnecessary, as the stand is exceedingly simple in design.

The Development of *Pleurococcus*.

BY THE EDITOR.

More than a year ago Mr. F. Wolle, in the course of private correspondence, stated that the common *Pleurococcus*—the pulverulent, green alga, found everywhere on old fences, tree-trunks, etc.—was a stage in the growth of *Ulothrix*. The evidence in support of this statement, however, was not given, and we are still unacquainted with the observations upon which it was based. At the time, we endeavored to cultivate the plant, and induce it to take on a filamentous growth, but all our efforts in this direction failed. The unicellular condition persisted, and we were forced to the conclusion that the only way to follow the development of the plant was to watch it in its native habitats at all seasons.

On the fourth day of February, this year, when the weather was very mild and ice was melting rapidly, we found some *Pleurococcus* on moist rocks in Central Park. On examining it carefully many of the cells were observed to be taking on a filamentous form of growth. This was the first time we had seen any such tendency manifested by the plant, and the discovery was a surprise.

The cells of the *Pleurococcus* varied in diameter from 5.8μ (.00023") to 10.8μ (.00041") or even 11μ . If we except the presence of a distinct gelatinous envelope, which surely does not exist in our specimens, the species corresponds to *P. angulosus*. The filamentous plant consisted of a series of nearly square cells measuring about 7.25μ (.00028") in diameter. It agrees with *Ulothrix compacta* tolerably well, and we have given it that name.

The conclusion from these observations strengthens the position which Mr. Wolle has maintained for several years, and which he has expressed

quite recently, in a letter, in these words: "I reason from analogy and say that all the forms of *Pleurococcus*, *Protococcus*, *Chlorococcus*, *Glaucocapsa*, etc., belong to, and are mere developing forms of, higher algæ. I have had such positive evidence of transformations I cannot think otherwise."

Kirchner, a very accurate and experienced observer, says: "The genus *Protococcus* contains a number of heterogeneous forms of which certainly the most, if not all, are developing forms of higher algæ, as copulating microspores, resting macrospheres, or products of a peculiar disintegration of filamentous plants, as noticed by Cienkowski."

We are not quite prepared to accept the conclusions thus indicated, even from such high and respected authorities. It cannot be said that the conclusions are fully supported by observation. Very many of the unicellular plants are known to pass through different stages, and to propagate indefinitely without, so far as we yet know, assuming a higher, or in anywise more complex, stage of existence. It seems hardly proper to generalize freely concerning a subject of which comparatively so very little is known. We are prone to be conservative about it, for the reason that it is in strict accord with the system of the development of plant and animal life in the world, that there should be a certain number of algæ which have never advanced beyond the most primitive condition of cellular life. While it is true that some unicellular forms have been observed to develop into higher plants, we have no means of distinguishing between a true spore—a product of some process of propagation of a filamentous plant having the strange potency to reproduce its parent form,—and its prototype, which never advanced beyond the unicellular stage; as the ovum, in its earliest stages, is to the eye the same, whether it encloses the germ of bird or beast or man. Surely we must have some forms of plant-life that have not advanced beyond the condition of a primitive cell.

Ethyl-Æther of Gallic Acid, and a New Mounting Material.

BY PROF. CHRISTOPHER JOHNSTON, M.D.

In the month of November, 1882, my young friend, Dr. R. Dorsey Coole, of the Johns Hopkins University, kindly gave me a little vial, containing a pale buff powder composed of minute acicular crystals, and labelled Ethyl-Æther of Gallic Acid. And he added to the favor by furnishing me with the formula indicating its constitution, as thus: $C^6H^2(OH)^3COOC^2H^5$

I found this substance to be most readily soluble in water, alcohol and æther, and to crystallize out on the slide in masses of irregular rhombic form, in needles, in elongated prisms, and in discs of many sizes, and, according to thinness, of various colors, beginning with the steel gray, passing through blue-gray, and ending in hues as vivid as it is possible to conceive. The smaller crystals, however, were

in the majority, and greatly marred the beauty of the preparations.

But I was doomed to disappointment in discovering that the film of splendid, glowing forms, discs and rosettes, sooner or later began to fade, and, in most instances, dissolved, and like the baseless fabric of a vision left not a rack behind. The dimmed brilliancy of a few slides, however, attested the beauty of the object, and one of these attracted attention at the last public exhibition of the Baltimore Microscopical Society, held in the spring of the present year. After that meeting I resolved to test some better modes of preparing the crystals; and, what was indispensable, to find a mounting material—for they must be embalmed, and will not endure the air—which should preserve and not extinguish the film. I therefore instituted the following experiments in mounting crystals of ethyl-æther of gallic acid, coming out of solution in absolute alcohol.

MATERIAL.	RESULT.
1. Pure, soft Canada Balsam.	Dissolved the crystals.
2. Old Canada Balsam in Chloroform.	" " "
3. Old inspissated Chian Turpentine with common Turpentine.	Dissolved much, especially the thinner gray rosettes.
4. Old hard Damar in Turpentine (dried out of a Benzole solution).	Dissolved nearly everything.
5. Damar and Mastic in Benzole.	Dissolved everything, or at least destroyed.
6. Boiled Linseed oil and No. 3.	Dissolved.
7. Copal Varnish (Coach).	Dissolved.
8. Castor oil.	Dissolved.
9. Best Piano Copal Varnish.	Dissolved finer parts.
10. Oil of Amber.	Dissolved.
After these failures I sought new combinations, thus:	
11. A drop of Petrolina oil upon the slide, followed by a drop of No. 3.	Partial success.
12. Balsam Copaiba.	Quite good.
13. Boiled Balsam Copaiba.	Very good.
14. Boiled Copaiba and old Chian Turpentine.	Very excellent—but the ghostly crystalline plates vanish slowly.
15. First a drop of boiled Copaiba, then old Chian Turpentine dissolved by boiling in Balsam Copaiba.	The best success, but not perfectly satisfactory.
16. Boiled Balsam Copaiba thickened decidedly with clear Virgin Rosin of a pale straw color.	Preserves everything unless it be the dark-looking rhombs which yield if proceeding from certain solutions. Even salicylate of Cinchonidia remained about firm.

While making these experiments I essayed various media for making solutions out of which the substance should crystallize. Distilled water gave indifferent results; as also, water holding gum arabic in solution. Sulphuric æther was excellent, and absolute alcohol still better; but what made success assured, was the employment of glacial acetic acid added to absolute alcohol, in the proportion of from five to twenty per cent. To this mixture was added the ethyl-æther of gallic acid, in the proportion of from five to twenty per cent., dissolved in a small test-tube, preferably without heat, and distributed upon glass slips, as follows: Let a thin slide be held with the left forefinger and thumb, and on its left end let there be poured a quantity of the solution, quickly made to run over the rest of the glass, and to drain at once into the reservoir tube. Then let it be laid flat, and protected against dust, for evaporation. The operator should prepare many such slides — make some lie flat and others inclined — and when perfectly dry, should pass the slides between the Nicols, using an inch objective, and mark the best spots with ink on the back.

After some hours the chosen crystal film is mounted, by touching the centre with a small drop of the rosin and copaiba, placing upon it a cover-glass, pressing this rather firmly down, and allowing capillary attraction with time to complete the even spread.

At leisure a diamond cuts out the mounted parts, and tragacanth attaches them upon wooden slips with a $\frac{5}{8}$ inch aperture; when, after labeling, the preparations will be complete. And the bits may be further secured by running a solution of shellac along the edges.

I much prefer this mode of preparing such objects for the polariscope, for the chances of the best fields are greatly increased, as well by the extent of surface as by the varying quantity of its solution, at the ends, sides and middle. And be assured that

the centre of the slide will be the last place to look for the most successful grouping.

Finally, dust the surfaces of the cover-glasses protecting these preparations gently with a camel's-hair pencil; but on no account wipe them until some months shall have elapsed.

The figures presented are chiefly discs and rosettes, in all varieties of grouping and size; some thin, grey or bluish, others larger or smaller, of the most intense hues; some coalesced and others discreet; some delicately fringed, while very rarely indeed the most beautiful disc occurs, of moderately large size — microscopically speaking — with corrugated radiations proceeding from a central sharp-cut cross, surrounded with a ring of color before it sends out its brushes, and ending in a ruffled margin of several rows deep. The elegance of the preparation and the certainty of its preservation, even in the copaiba and rosin fluid depend, as I have found, upon the circumstances attending the crystallization; one of these attaches to the perfect drying of the film and the dissipation of the acetic acid; and the other refers to the solvents employed. The best of these, in my experience, for the ethyl-æther of gallic acid, are absolute alcohol acidulated with the glacial acetic acid; and the other, even better, perhaps, an equal mixture of absolute alcohol and sulphuric æther acidulated from five to ten per cent. with the same acid. And, if these conditions be attended to, there need be no doubt as to the result.

I would add, in conclusion, that ethyl-æther of gallic acid, salicylate of cinchonidia, cholesterine, and some other substances, being very soluble in Canada Balsam, I have treated them by placing a small quantity of either upon a drop of recent balsam, melting by heat, and placing and pressing down firmly a warm cover upon the saturated fluid. And the drop may be stirred or not stirred. In time most charming crystallizations

present themselves, and are permanent, because the mounting fluid remains saturated, having parted with its excess only.

NOTE.—Since writing the above I have much improved upon medium No. 16 by substituting the very best damar resin for the rosin; that is to say thickening to the consistency of molasses, and by heat, boiled balsam copaiba with the clearest tears of damar. Slides of ethyl-æther of gallic acid mounted in this No. 17 medium, greatly surpass in beauty all former successes.

BALTIMORE, September, 21, 1883.

EDITORIAL.

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SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

TESTING OBJECTIVES. — The article published this month on the above subject is deserving of more than passing interest from the microscopist. The method is one readily applied by any experienced observer, and the apparatus required is inexpensive. Any of the dealers in microscopical apparatus can furnish the Abbé test-plates made by Mr. Zeiss; Mr. Emmerich being the agent of Mr. Zeiss in New York, will undoubtedly have them in stock. The value of the method is quite independent of any theoretical consideration. It does not offer a test which is only true if the present theories of microscopical vision are true. Although it originated in a more perfect knowledge of the microscope, springing mainly from the investigations of Prof. Abbé, than was hitherto possessed even by the most learned physicists, it affords a means of examining the image formed by the objective, and indicates imperfections

in the image which must be regarded as such without regard to any theory. Consequently it affords a means of comparing different objectives, which gives results beyond the influence of the opinions or predilections of the observer, and which, in the hands of a conscientious person, enables the relative excellence of different objectives to be determined, and definitely stated. How long it will be before this method is in general use by microscopists it is impossible to say, but its advantages are so great, especially for those who wish to purchase thoroughly good objectives, and in assisting those who are frequently asked to express an opinion as to the merits of objectives for inexperienced friends or acquaintances, that we hope to see it widely adopted in this progressive country. It may possibly be true that in certain rare cases the general efficiency of an objective may be advantageously sacrificed to obtain the greatest possible resolving power. We would not wish to commit ourselves to the opinion that this is ever the case, but we admit the possibility. Closing with the following quotation from Dr. Fripp's article, we commend it to the careful attention of microscopists: "The employment of the test-objects most in use is, moreover, calculated to lead to an entirely one-sided estimation of the actual working power of an objective, as, for example, when 'resolving power' is estimated by its extreme limits rather than by its general efficiency; or 'defining power,' by extent of amplification rather than by clearness of outline. So that an observer is tempted to affirm that he can discern through his pet lens what no eye can see or lens show."

THE DISTRIBUTION OF LIFE IN THE SEA. — At the Great International Fisheries Exhibition, in London, among the various forms of apparatus used in deep-sea research there is shown, in the United States Section, a copper cylinder about two feet in length by one foot in diameter attached in a pe-

cular manner to a strong, vertical, steel wire-rope. Within the cylinder there is a strainer, near the top, and at the bottom there is a valve which opens upwards so that water may flow through the cylinder as it descends in the sea, and the strainer will retain the creatures that may be living in it. The purpose of this apparatus, which was devised by Capt. C. D. Sigsbee, U. S. N., is to assist in the study of the vertical distribution of life in the sea. The method of using it is as follows: Suppose the exploring vessel has reached a station where it is desired to know the character of the fauna at a certain depth — we will say between 100 and 150 fathoms. A sinker is attached to the wire rope, and a few feet above it a brass stop, the purpose of which will soon be made clear, is firmly secured. The rope is then paid out until the stop is 50 fathoms down, when the cylinder, or gravitating trap as it is called, is attached. The paying out is then continued until the stop reaches the depth of 150 fathoms, when the trap will be at 100 fathoms. Down to this point the trap has remained closed, and filled with filtered water, quite free from living forms. It is now necessary to open the trap, and allow it to glide down on the rope until it reaches the stop at 150 fathoms, which will close it automatically. This is done by sending a conical weight, or messenger, down on the wire which releases the trap from its fastenings, when its weight carries it down, while at the same time the valve in the bottom is set free and opens, allowing the water to flow through the cylinder as it descends. The organisms in the water between 100 and 150 fathoms are thus collected and brought to the surface for examination. The observations that have been made with the aid of this ingenious contrivance have shown that microscopic animal life in the sea is confined in depth to two narrow zones, one at the surface and the other at the bottom, the intermediate zone being quite devoid of life.

On the "Challenger" expedition the tow-net was used by Mr. Murray at depths of 500 and even 1000 fathoms, but the results were not to be relied upon. The tow-net brought up living forms in all cases, but as these might have been collected near the surface as the net was rising or sinking, Prof. Agassiz asked the coöperation of Capt. Sigsbee in devising an instrument to settle all doubts, and the gravitating trap was the result.

In many places, when the water is smooth and the sun brightly shining, the surface swarms with pelagic forms of life — annelid larvæ, medusæ, salpæ, radiolarians, pteropods, crustaceæ, globigerinæ, algæ, etc., abound, and afford rich hauls for the tow-net. If the surface is disturbed by winds the animals descend just far enough to be out of the range of disturbance. But they never go down very deep, as they find their food near the surface. It appears that the range in depth of the pelagic forms is limited to about 100, or at the most 150 fathoms, and by far the greatest abundance of living creatures is within 50 fathoms of the surface.

In the science and art department of the South Kensington Museum there is a large chart of beautifully executed and colored drawings, representing the surface oceanic life observed under the microscope by Francis I. Palmer, in H. M. S. "Rodney" between Hong Kong and England, and in H. M. Surveying Ship "Sylvia" between England and Ceylon.

The voyage of the "Sylvia" was made during the time from December 1866 to March 1867, the homeward voyage of the "Rodney" was made from Sept. 1869 to April 1870. The collections were made by towing nets of fine gauze behind the vessels, at speeds ranging up to ten miles an hour.

On this chart there are over 600 drawings of microscopic animals, each of which is also represented by a dot or mark showing its natural size. They embrace a great variety of

forms, ranging from the rhizopods even up to the vertebrates.

The work done in making these drawings and observations was very great, for it has been calculated that the 605 drawings on the chart required the examination of a quarter of a million different specimens under the microscope. During the homeward voyage of the "Rodney" upwards of 1300 drawings were made, and on the "Sylvia" five hundred.

A SIMPLE EYE-PIECE MICROMETER.

—Mr. W. M. Bale describes a simple form of eye-piece micrometer, which seems worthy of adoption by amateurs who enjoy using home-made apparatus. Judging from the description we would recommend it as both accurate and convenient, and it seems to possess qualities for practical use which commend it to the favorable notice of professional observers. It consists of two or more delicate fibres of silk stretched across the diaphragm of the ocular. It will require but little description to enable a person of ordinary ingenuity to construct one. Remove the field-lens of the ocular and apply a very little stiff balsam to the under side of the diaphragm at two points diametrically opposite. Ravel out a very fine, straight fibre of silk from a ribbon—the transverse fibres of a corded ribbon will serve very well. Attach one end of the fibre to the diaphragm by placing it in the balsam, and stretch it across to the other side. Be sure the thread is smooth and straight. When it is so, a second thread must be laid parallel to it, in the same way. The difficulty now met with is to get the two threads parallel and at the right distance apart. This is accomplished by placing a stage-micrometer upon the stage of the microscope, and adjusting the fibres until they correspond with the lines on the micrometer. Suppose the stage micrometer is ruled in thousandths of an inch. If the lines in the eye-piece exactly correspond, they

will measure thousandths of an inch with the objective used. If they do not exactly correspond, they may be made to do so by moving the draw-tube out or in. Then mark the proper position of the draw-tube, and there will be no further use for the stage micrometer except to detect any accidental change in the position of the fibres. It is recommended that the fibres be secured by strips of gummed paper in addition to the balsam. It is well to have these fibres, equally spaced, and to adjust them to measure thousandths of an inch, or else micras (.001 mm.), with a $\frac{1}{4}$ or $\frac{1}{8}$ inch objective.

It seems not improbable that micrometers made in this way will be found to possess advantages over simple rulings on glass. They do not interfere with the optical perfection of the eye-piece, and if the fibres are accurately placed, so as to be quite parallel, they will prove in every way satisfactory. If any of our readers construct such micrometers, we would be pleased if they would make known their experience with them through the JOURNAL.

A PRINTER'S BLUNDER.—In the August number of the JOURNAL the printer has made a most annoying blunder. On page 149 begins a portion of an article referring to the Fisheries Exhibition in London, and having no connection whatever with the preceding matter. The Editor can only express regret that such a blunder should have been made.

THE AMERICAN ASSOCIATION.—The meeting at Minneapolis this year seems to have been rather poorly attended, and in consequence not much was done in the section of microscopy and histology. The Vice-President, the Hon. J. D. Cox, presided, and Mr. Walmsley was made Secretary *pro tem.* in the absence of Dr. Carl Seiler. We have no reports of microscopical papers presented be-

fore the section. The Vice-President of the section for the meeting next year is Prof. T. G. Wormley, who is well known to microscopists, and the secretary is the editor of this JOURNAL.

NOTES.

— We have already referred to some fine embryological specimens which have been introduced in England, prepared by a new method. The slides we had then examined, mostly consisting of eggs of small entomostraca, seemed to have been remarkably well-preserved. We have since had the pleasure of meeting the gentleman who prepares the specimens, Mr. E. Lovett, from whom we have learned some particulars of the method of preparation. The composition of the fluid used will be made public in the fall, but at present we are not at liberty to disclose it. None of the specimens are allowed to go out until they have been in the preservative at least six months, so as to ensure them against future change after they are mounted. The cement used has been subjected to extremes of temperature from 28° to 120° F. without the slightest effect upon the mount, and a set of the slides exhibited at the Fisheries Exhibition, where they have been subjected to strong sunlight in a glass case, shows not a single damaged specimen. When Mr. Lovett publishes his method of mounting, microscopists will be under great obligations to him for a method that has stood the test of time so perfectly. The slides are for sale here by Messrs. Sinel & Co., of St. Heliers, Jersey, and by C. Baker, Holborn, London.

— In a notice of Dr. Sternberg's new book on "Photomicrographs and How to Make Them," a writer in the *Scientific American* who, it would seem, is not especially well-informed on the subject, appears to be quite taken aback by the word photo-micrography. He says:—

"This handsome volume, which the author in his preface calls 'little,' although containing over two hundred octavo pages, is intended for beginners in the art of micro-photography—a term more definite than the inverse of photo-micrography, chosen by the author."

For ourselves, and in behalf of all lovers of good English, we are constrained to defend the use of the word photo-mi-

crography in the sense it is used by the author of the book. Not to enter upon a philological controversy, we would call the attention of the author of the above criticism to the fact, recognized by all microscopists, that the word micro-photograph means a small photograph, while the term photo-micrograph means a photograph of an image formed by a microscope.

— Mr. Walmsley gives the following table of the proper exposures with Beck's objectives in photographing with his apparatus, using lamp-light and very sensitive plates:—

OBJECTIVES.	EXPOSURES.
$\frac{1}{2}$ inch	2-3 minutes.
$\frac{3}{8}$ inch	3-4 minutes.
$\frac{1}{4}$ inch	7-10 minutes.
$\frac{1}{8}$ inch	8-12 minutes.
$\frac{1}{10}$ inch	15-20 minutes.

— Mr. H. J. Slack recommends the use of paraffine oil for the examination of living aphides. The insects may be placed in a good quality of petroleum oil, in a cell, and examined with various kinds of illumination, a very pleasing effect being obtained by the use of the Lieberkuhn in conjunction with an achromatic condenser with the central stop for dark-ground. The insects will live for some time in the oil, occasionally for hours. This method is certainly superior to the ordinary way of examining living creatures. Another method which possesses some merit we noticed at a meeting of the Quekett Microscopical Club. The insects were in a round shallow box on the table, and by means of a substage condenser a miniature image of the bottom of the box was formed in the focus of the objective. This is an excellent and very easy method of displaying living insects under the microscope.

— In describing the new microscope made by Messrs. W. Watson & Sons, of London, which we have already referred to in these columns as a copy of Mr. Bulloch's "Biological" stand, the editor of the *Journal of the Royal Microscopical Society* alludes to Mr. Bulloch's design in the following appreciative words:— "We have always considered Bulloch's Biological Microscope to be one of the handiest and most practical forms of stand made, and equally useful for biological examinations and for the more special examinations of test objects." This is praise from high quarters, of which Mr. Bulloch may be justly proud.

— The microscopist who occasionally photographs his specimens finds that his developing solutions deteriorate by keeping, and often when he comes to use them, after standing untouched for some time, they do not act properly. Especially is this true of developers containing pyrogalllic acid, which, as ordinarily made, soon lose their strength. It is customary to make up the solutions and keep them ready for use, but owing to the circumstance above mentioned this plan is not a good one for microscopists who only use them occasionally. We have adopted the following plan for developing, which enables fresh solutions to be readily made without loss of time. We have always at hand citric acid and pyrogalllic acid in powder, strong ammonia (.880), and a solution of potassium bromide, 50 grains to the ounce of water. When about to develop the plates dissolve 1.5 grains of citric acid in 8 ounces of water. In practice it is not necessary to weigh out the exact quantity, as it can be measured on the point of a knife, after a little experience. Then take $\frac{1}{2}$ drachm of ammonia and mix it with 8 ounces of water. Go into the dark room with the solutions, put the exposed plate into the developing dish, and proceed as follows: For a 4×5 plate take one ounce of the citric acid solution and add to it 2 grains of the pyrogalllic acid in powder, measuring that quantity in the hand, or on a spatula. It dissolves almost instantly. Then add one ounce of the ammonia solution and a drop or two of the bromide, and flow the whole over the plate. The development proceeds slowly, and may be controlled in the usual manner by adding more bromide, or a few drops of dilute ammonia, as the case may require.

CORRESPONDENCE.

A GOOD OBJECTIVE.

TO THE EDITOR.—In your Journal for March you gave us "An evening with *Amphipleura*." On the 28th of April, I received an objective from Messrs. H. R. Spencer & Co. marked " $\frac{1}{10}$, Hon. B. A., 125," with the remark, "We think the $\frac{1}{10}$ does the finest work on *Podura* that we ever saw." During the month I have tried it pretty thoroughly on the slide of *Amphipleura* which I send to you, with the following results. It resolves the sin-

gle frustules with daylight above or beneath the stage, with concave mirror alone, in homogeneous fluid or in glycerin. By lamplight and concave mirror with bull's-eye condenser with either fluid. It also resolves them readily by central sunlight.

I do not regard the *amphipleura* on Möller's probe-plate as a test for our best glasses, and send you some from this vicinity. I would be pleased to have you or your friends try the best glasses of other makers, on this slide, and let the public know the results. I have reason to believe that my objective is superior to the one you refer to in your article.

JOHN SLOAN.

NEW ALBANY, IND., May 30th, 1883.

[We have been unable to examine the *amphipleura* sent by the writer as yet, but will do so at an early day, when our readers will be informed of the results. Absence from home has greatly interfered with practical work with the microscope. — ED.]

CLEANING DIATOMS.

TO THE EDITOR.—I have for a year or two at times cleaned up a good many diatoms, and find that a method not described in any of the books, so far as I know, works better than any of the approved ones.

The diatoms are to be freed as far as possible from water, by decanting it off. Then covered with a liberal quantity of pure concentrated sulphuric acid, which is heated to boiling in a good porcelain evaporating dish. Continue the heating till the white fumes of sulphuric acid begin to escape freely, and then, while still over the lamp, add potassium nitrate (saltpetre) in bits of the size of a pea, waiting after each addition till the effervescence ceases before adding more. Continue till the whole mass in the dish is white or light yellow. This will not usually take more than 5 minutes. Then wash the cleaned diatoms with successive portions of distilled water as usual.

J. Y. BERGEN, JR.

LOMBARD UNIVERSITY, }
GALESBURG, ILL. }

MICROSCOPICAL SOCIETIES.

The Annual General Meeting for the election of officers was held by the Quekett Club on the 27th of July, when the following officers were unanimously elected:

President, Dr. M. C. Cooke; Vice-Presidents, Mr. A. D. Michael, Mr. E. T. Newton, Mr. C. Stewart, Mr. T. C. White; Treasurer, Mr. F. W. Gay, Secretaries, Mr. J. E. Inghen, Mr. G. C. Karop; Foreign Secretary, Mr. H. F. Hailes.

At a meeting of the Biological Society of Washington, Dr. Thomas Taylor presented an article on "Actinomykosis, the fungus growth on the throat and lungs." He illustrated it with photographs of enlarged microscopic views of the fungus in different stages of development. He said: The fungus actinomyces is supposed to be the cause of a deadly disease named by the Germans actinomykosis. This disease is closely allied to tuberculosis, and is sometimes confounded with it. It produces large tubercles on the trachea, consolidates the lungs, depositing calcareous cartilaginous nodules, death ensuing by asphyxia.

The thoracic viscera of a Newfoundland dog which died of an unknown disease was sent to Dr. Taylor for microscopic examination. The base of the trachea was covered with large tubercles, some of them an inch in diameter. The two principal lobes of the lung were white and consolidated, and a soft, gelatinous substance, about half an inch in diameter and three inches in length, extended from the largest tubercle of the trachea to the apex of the right lung. On examining a portion of this gelatinous body under the microscope, Dr. Taylor found it to consist of the mycelium or spawn of a fungus, hitherto undescribed in mycological works. The fungus exhibited new and peculiar points of interest. Its cell-structure was of the most varied character, each individual cell having a yellow-colored patch within it. Branching out from the mycelium, or spawn, were numerous stalks or pedicles bearing the fruit of this fungus, having the appearance under the microscope of a tiny forest of microscopic mushrooms, each of these mushroom-like forms being not over one-thousandth of an inch in diameter. On examining the bronchi of the lungs traces were found of branches of the mycelium. It then occurred to the doctor that he might be able to cultivate this fungus from this spawn, and thereby obtain a life-history of this microscopic plant. This he succeeded in doing, and discovered at least eight distinct stages of its growth. He found also by experiments that every stage of its growth had

the power of reproduction. Dr. Taylor illustrated his remarks by drawings and photographs and mounted slides of the fungus in its various stages shown by microscopes of high power. Dr. D. E. Salmon followed Prof. Taylor in a sketch of the pathology of the disease. My remarks, he said, are intended to be suggestive rather than to bring up all the details that have been observed in connection with the subject. There are a number of reasons why this fungus and this disease are peculiarly interesting. In the first place, it is another addition to the list of germ-diseases. The presence of this fungus in all cases of disease of a certain character in various parts of the world, and its growth in the interior of the affected parts, together with the fact that the trouble may be communicated from one animal to another by inoculation, are the chief points which connect this organism with the causation of the disease.

Although it grows in the deepest organs of the body, the lesions produced are of a local nature. It does not multiply in all parts of the body at once, nor in the circulating liquids, as does the germs of some contagious fevers; but it is generally confined to a particular organ, in which it forms a swelling or tumor of a progressive nature which usually ends in death. In this respect it forms a connecting link between the diseases produced by fungi and by bacteria. While the latter in certain diseases multiply in all the liquids of the body, there are other cases in which they are unable to penetrate beyond the affected organ, or at least not until the last stages of disease. This fungus is also interesting because of the number of distinct species which it attacks. Sixteen cases in the human subject have already been recorded, while it is known to affect horses, cattle, swine and dogs.

To the investigator of contagious diseases this subject is peculiarly interesting at present, because the lesions so closely resemble those of tuberculosis and scrofula. The new views in regard to the contagiousness of tuberculosis and its parasitic origin, have been chiefly combated by those who consider all tubercles to be pathologically identical; while the truth seems to be that the same appearance may be produced by a variety of causes. Thus, but a few months ago a French investigator described a form of tubercles that was even microscopically identical with what is known as true tu-

bercle, with the single exception that at the center of each granulation was found the microscopic egg of a nematode worm. And in the disease under consideration we have another variety of tubercle that seems to differ only in that the center of each granulation consists of a tuft of the actinomycetes fungus. It seems probable, therefore, that what has heretofore been looked upon as a single disease may be divisible into a number of distinct diseases, and that this may prove to be a partial explanation of the discrepancies in the results of different investigators.

Since this organism multiplies locally it is evident that, as a rule, it gains entrance to the body near the seat of the resulting disease. A slight wound, an abrasion, a scratch, even, may be sufficient for its lodgement; while it seems probable that it may, at least in certain cases, vegetate on the moist mucous membrane, even when uninjured, and send its mycelium into the tissues beneath, there to produce the disease in all its intensity. The tubercles of the lungs seem to be the result of the vegetation of spores that have been inspired with the air. And it is not unlikely that the germs which cause the lesions of various parts of the digestive tract find their way to the mouth in the same manner.

NOTICES OF BOOKS.

Photo-Micrographs and How to Make Them. Illustrated by forty-seven photographs of Microscopic Objects, Photo-Micrographs Reproduced by the Helio-type Process. By George M. Sternberg, M. D., F. R. M. S., Major and Surgeon U. S. A., etc., etc. Boston: Jas. R. Osgood & Co., 1883. (8vo., pp. 204, cloth, \$3.00.)

Dr. Sternberg has given in this volume a very clear, concise and complete description of his method of making photo-micrographs, in which he has achieved very great success. He has divided the book into two sections, the first of which treats of the "Technology" of the subject, relating to Light, Microscopical Apparatus, Camera and Photographic Material, Arrangement of Microscope and Camera, Operating Room, Focussing, Exposure, Development and Preservation of Negatives, Photographing by Reflected Light, making of Positives upon glass, and the

Selection and Preparation of Objects. The second part contains a description of the plates and occupies nearly one-half of the book. The plates contain the following figures: *Amæba*, micrococci, unicellular algæ, *Englena viridis*, spores of fungi, epithelium cells, scales of insects, blood-corpuscles, pollen-grains, epidermis of plants, plant-hairs, sections of vegetable tissues, five plates of diatoms including a handsome photograph of the fourth square of Möller's "Diatomaceen Typen-Platte" $\times 50$, sections of animal tissues, parasites, teeth of mollusca, trachea of insects.

The book is handsomely printed in large type, on heavy paper, and well-bound. We reserve some further references to this useful book for a future occasion.

Exchanges.

FOR EXCHANGE.—First class double-stained sections of Magnolia, Fig, Orange, Oleander, Butter-nut, Birch and many others; also fine injected specimens. N. A. Richards, St. Louis, Mich.

FOR EXCHANGE.—Slides of pollen of pitch pine, *Pinus rigida*, with the connection stained, for any named slides of algæ. Dr. C. F. Millsbaugh, E. M. S., Binghamton, N. Y.

WANTED.—*Trichina Spiralis*, *Pleurosigma* Ang., or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

WELL-MOUNTED slides of Polycystina, transparent and opaque, for any well-mounted slide. P. C. Cole, M.D., 254 West Forty-second Street, New York, N. Y.

WANTED.—Slides of Bacteria in exchange for other slides, or for cash. J. M. Adams, Watertown, N. Y.

WANTED.—I will give a good type slide of diatoms, or a slide of arranged diatoms, for a gathering of *Pleurosigma angulatum*. Thos. Christian, 108 Virginia St., Richmond, Va.

Fossil Diatoms from Carson, Nev., and Fosa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

41 ARCH ST., BOSTON, MASS.,
Nov. 15, 1883.

DEAR SIR :

At the close of the present year we shall discontinue the publication of the American Monthly Journal of Microscopy, but in its stead we would call your attention to SCIENCE RECORD, a monthly journal of scientific notes and news, in which all that relates to the Microscope, its use and its discoveries will occupy a prominent position. Especial attention will be given to microscopical technique, including descriptions of improvements in staining, section-cutting, mounting and hints concerning the management and use of this important instrument. All theoretical questions of little practical importance and less popular interest will be omitted.

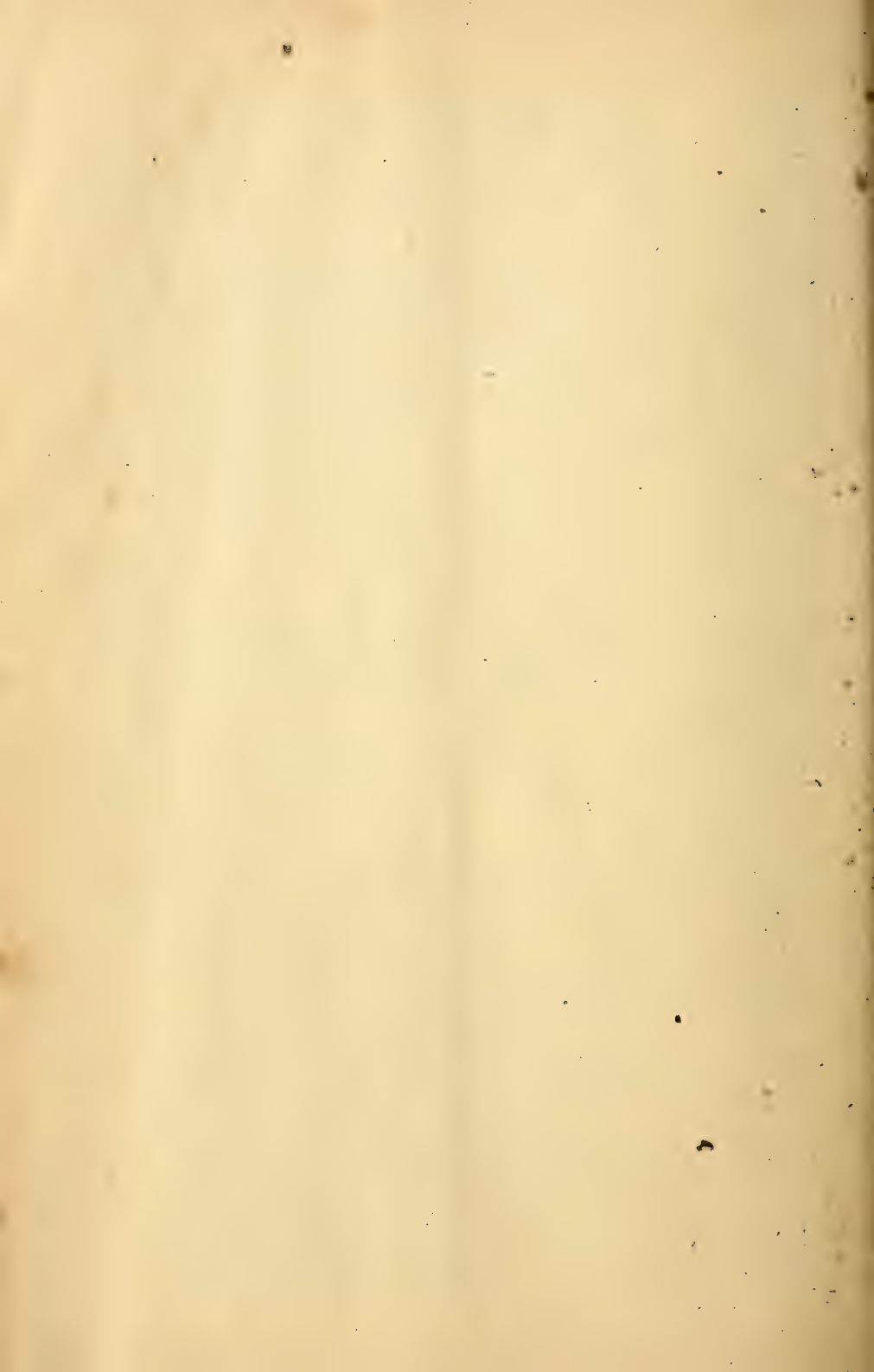
Besides the Microscopical department, SCIENCE RECORD will strive to give in a concise form and in popular language the scientific news of the world, including, besides the important discoveries in all departments of science, personal notes, answers to correspondents, editorial notes and reviews, and notices of books, papers and periodicals received. Illustrations will be used when necessary to as large an extent as the subscription list will warrant.

The editorial management will be in the hands of J. S. Kingsley of Malden, Mass., and to him should be sent all exchanges, books and papers for review as well as all correspondence relating to the literary portion of the journal. Mr. Kingsley will be aided in his labors by several of the prominent scientists of America and every care will be taken to render the paper newsy, readable and reliable.

A sample copy is sent you to-day. The subscription price is One Dollar a year, payable in advance, and we hope to enter you upon our lists.

We are yours very truly,

S. E. CASSINO & COMPANY.



THE AMERICAN MONTHLY MICROSCOPICAL JOURNAL

VOL. IV.

BOSTON, NOVEMBER, 1883.

NO. 11.

Public Aquaria.

It is said that when King Henry VIII. inquired of the Abbot of Abingdon what was the depth of the sea, the learned Abbot answered, "A stone's throw, an't please your majesty's highness." We could answer the question to-day with rather more accuracy. If we throw a stone overboard in the deep sea, it would take half an hour for it to reach the bottom. About 150 miles from St. Thomas, the depth is about five miles and a half. The topography of the sea-bottom is being very carefully studied, and the dredge and trawl are sent down to bring up specimens of animal and plant life from the submerged plateaus and valleys. Strange and beautiful forms of life are found in the sea, of which few persons have any conception. No description can convey an adequate idea of the anemones with their spreading tentacles and delicate colors. The white coral skeletons in cabinets give no hint of the beautiful living creatures that formed it. The forms of the animals that live in the water are so strange and varied, and so different from anything we are familiar with in daily life, that they possess a special interest whenever they are exhibited, either living or dead.

For this reason many attempts have been made to establish large marine public aquaria, where such creatures could be kept alive in glass tanks, and studied at leisure. The history of such efforts has been discouraging. Very few public aquaria are now in successful operation. Of these, scarcely half a dozen are famous. Never-

theless, the writer is firmly convinced, after long consideration of the facts, and a careful study of the causes leading to success or failure, that an aquarium can be established in almost any one of our large cities, such as New York, Boston, or Philadelphia, which would be a permanent attraction, and, if not quite profitable as a mere business investment, it could be made self-supporting from the beginning.

At first sight it may seem scarcely appropriate to the pages of this magazine, to advocate at length a scheme which appeals more to naturalists in general than to those who are especially engaged in microscopical studies. Yet, viewed broadly, from the standpoint of the scientific man, who draws knowledge from every source, and pleasure from every work of nature, and who sees in every enterprise tending to reveal the handiwork of nature something to educate and elevate his fellow man, the subject is not appropriate to these pages.

The venerable naturalist and collector, the Rev. Henry H. Higgins, to whose earnest labor is largely due the arrangement of the specimens of invertebrates in the free public museum of Liverpool — an arrangement which places that museum among the best in the world for purposes of public instruction — says: "A specimen without a history, or even without a name, that calls forth a genuine exclamation 'How beautiful!' fulfils a noble mission, especially when the observer is a child or young." This is the expression of a man who has devoted the best years of his life

the cause of public instruction. It carries with it, therefore, the weight of experience—experience in the noblest work of life, that of an earnest effort to instruct and elevate mankind.

A laboring man from the north country, visiting the museum, was struck by the beautiful forms of the madreporé corals, and, calling to his wife, he exclaimed, "They be sea-crystals, all different sorts of crystals as grow in the sea." Had he stopped to read the explanatory cards he would have known that they were produced by the growth of beautiful animals. But it was enough for him that they were beautiful; and by his sincere appreciation of that one characteristic, his mind was elevated, be it ever so little, above the plane of sordid existence.

If skeletons and shells can thus impress the untutored mind, how much greater must be the influence of the sight of the living animals which have mysteriously formed them! Herein is the value of an aquarium as a means of instruction. Tell a child that the shells he plays with were once the houses of living animals, and he will wonder what kind of animals could live in such coiled and irregular shells. This is an example chosen from our own experience. How clearly the writer remembers the almost incredulity with which he first heard that an animal lived in the shells—how could such a large animal as would fill the interior of the shell be held in his hand, crawl in and out through such a small doorway! The idea that the shell was carried about on the animal's back was never thought of. Even now we might find one of the identical shells that so aroused our wonder in the days long since. Such are the strange notions of childhood; and the teacher who is most successful is that one who can not only direct the thoughts of the young, but also detect the channels through which they are most likely to run wild. Show the child a living gasteropod, and then all will be clear to him; for he will see

at a glance how the animals live and move about and eat. So much for an object-lesson from the pond or garden-snail. A simple one, indeed, but perfectly adapted to the needs, as well as to the capabilities, of a child. Not for a child alone, for probably not ten of a dozen older persons the city through could tell where the mouth or the eyes of a snail are located.

To such persons a well-stocked aquarium would reveal almost a new world of wonders. Who can foresee the influence it would have upon the young and active minds of school children, by causing them to look deeply into the book of nature broadly opened before them, and seek, first for the strange and beautiful, afterward for the origin and reason and significance of it all! Everyone knows how people flock to a menagerie or zoölogical garden when there is a curious or unfamiliar animal to be seen. An unwieldy hippopotamus, or an ugly, ferocious, beast of any kind, will be sure to attract hundreds of persons. If people retain their interest in wild animals after having seen them many times, how much more must they find to interest them among the varied inhabitants of the ocean!

To the naturalist, a large and properly conducted aquarium would be of great assistance. Few persons are aware of the many valuable scientific observations already derived from studies at large aquaria, to say nothing of the great amount of work now in progress at sea-side laboratories, which does not now concern us. From a scientific stand-point, public aquaria are deserving of support. I think it was Prof. Edward Forbes who once wrote: "The naturalist whose acquaintance is confined to preserved specimens in a cabinet can form but a vague idea of the glorious variety of Nature, of the wisdom displayed in the building up of the atoms of matter to be the houses of life and intellect."

To take another view of the matter, some allusion may be made to what

has been accomplished in solving problems that have long puzzled naturalists. A very choice morsel for the palate is the white-bait, a small, delicate fish, about an inch in length, which is sold at an extravagant price in the English markets. It was long an undecided question among naturalists what these little fishes became when they attained their growth. It was supposed they grew into the herring, *Clupea harengus*, but owing to their peculiar habits no one could prove the relationship. Prof. Saville Kent, however, succeeded in keeping them alive for eighteen months in the Manchester aquarium, and was thus enabled to prove that the white-bait, *Clupea alba*, did develop into *Clupea harengus*. Such an observation could not have been made except under the exceptionally favorable opportunities afforded by large tanks supplied with thoroughly aerated, constantly running water, which can only be found in aquaria established for purposes of exhibition.

At the celebrated Brighton aquarium which is one of the most successful in England, for it has paid well, another disputed question has been settled in an interesting manner. It was supposed by some naturalists and fishermen that the ova of the cod and the whiting were deposited on the seabottom, and if so it was feared that trawling would destroy the spawn, and thereby diminish the product of the fisheries. Experiment proved, however, that the eggs of both those fishes would not sink, but floated on the surface of the water. At the same aquarium the rapidity of the growth of salmon has been studied. Not to weary the reader with other facts of this kind, probably enough has been said to indicate the utility of large aquaria for purposes of scientific investigation.

A few words now concerning the principles which determine success in maintaining the necessary conditions for life in aquarium tanks. It is needless to review the gradual progress of

knowledge concerning aquaria. It is well known at the present day that if the proper balance of animal and plant life be maintained in an aquarium, the products of respiration of the animal are removed from the water by the growing plants, and oxygen is given out in return. Although this perfect balance can be readily maintained in small tanks at home, it is not practicable to depend upon plant life to aerate the water on a large scale. In the year 1861 Mr. Barnum procured two living whales, some sharks, and one or two other inhabitants of the deep, which he kept for some time in tanks supplied with salt water from the river. This was the first public marine aquarium in America, and the method now in most favor for keeping animals alive in tanks is the same as Mr. Barnum then adopted, except that instead of pumping the water directly from its source, a supply is stored in underground cisterns, from which it is continuously pumped into the tanks and allowed to flow back into the cisterns. As the water flows from place to place, it becomes well aerated; and the same water may be used for years. In the Crystal Palace aquarium the exhibition tanks have a capacity of 20,000 gallons, while the reservoir contains 100,000 gallons more. It is a question whether such a large reserve supply is necessary, or indeed, whether any considerable volume of water besides what is in the tanks need be kept. There are two benefits to be derived from it, however, first, the temperature of a large volume in the cistern must remain tolerably constant throughout the year, and second, any disturbance in one of the tanks, causing the water to become foul or turbid, can be immediately remedied by drawing the water off into the large cistern, when it mingles with such a comparatively large volume that it can do no harm. The loss of water at the Crystal Palace aquarium has been calculated as only about 2 per cent, by leakage.

Although this article has especially

considered salt-water aquaria, it is by no means intended to neglect the attractions of the inhabitants of fresh-water, but to enlarge upon this portion of the subject would require to extend the article to an undue length. Public aquaria have not generally proved financially successful. Even now we would not advise any one to start one with a view to profit on the investment. Nevertheless, there can be no doubt that with proper management the running expenses could be paid from the beginning, and after a while funds would begin to accumulate. But we do not advocate this as a business scheme. It is advocated as a means of instruction for young and old, the founders of which will be entitled to the gratitude of the many who will be benefited thereby. Aquaria have failed in the past because of bad management, due, we may say, to imperfect knowledge of the conditions of success, or, when established for purposes of gain alone, because the managers have endeavored to draw the people after the manner of a circus menagerie. Those that have been managed economically have not failed.

Few places are more favorably situated for marine aquaria than New York and Boston, especially the latter city, lying so near the haunts of marine animals of great variety. But even in Chicago, were it not for the difficulty of keeping the more delicate animals alive during the long journey from the sea-board, a marine aquarium could be maintained as perfectly as on the coast. Even such difficulties can be overcome, but not without considerable expense.

Now that the experience of the last ten years has shown how an aquarium should be managed, may we not hope to see in America, one that shall rival those of England and Europe? It requires no costly edifice, nor a very great outlay for fitting up. The cost can be very accurately calculated. But let whoever undertakes the task not go at it blind-fold. No mere busi-

ness man can run an aquarium. It requires experience and knowledge which cannot be obtained from books alone. There must be a good naturalist at the head of it, who is deeply interested in his work, or the result will surely be disappointing.

New Members of the Infusorial Order Choano-Flagellata, S. K.

BY DR. ALFRED C. STOKES.

If our American waters had been extensively or systematically fished for microscopic fry, W. Saville Kent's magnificent monograph on the Infusoria would have contained many more references to the names of American workers among the animalcules, for our ponds are rich in material; yet the fishers seem to be few. Dr. Leidy and the late Prof. H. James-Clark are about the only American authorities to whom Kent refers. With this country "leading the world" as to excellence, not to mention price, of objectives, and with the infusoria showing themselves almost willing to be sacrificed, as Whipple says of the snakes and Agassiz, is it not time some one took up the subject seriously? The great obstacle, however, in the way of the satisfactory study of the minutest forms, among which much work remains to be done, is the apparently unnecessary cost of high-power objectives. What country student, who would care to fish among the infusoria, could spare one hundred and fifty dollars for a $\frac{3}{8}$ inch objective? And such a lens is needed for the satisfactory examination of certain important points in structure and life-history. The opticians and their prices make a combination which allows the infusoria to go scot-free.

The following forms, although they have not been examined with a $\frac{3}{8}$ inch objective, are believed to have hitherto escaped observation.

MONOSIGA.

With the exception of the sessilely attached *Monosiga Steinii*, S. K., the length of the body of the animalcule

here referred to as *M. robusta*, n. sp., is the largest yet recorded for any member of the genus. For this reason, and especially on account of the impression conveyed by its substantial appearance, robust seems an appropriate specific title.

M. robusta, n. sp.—Body ovoid, varying to subspheroidal, attached to the summit of a stout, rigid pedicel four to five times its length; collar about one-half the body in height; flagellum occasionally terminating distally in a bulb-like enlargement; contractile vesicles two, placed posteriorly. Body $\frac{1}{2500}$ inch in height. Solitary. Habitat.—Fresh water, attached to the rootlets of aquatic plants floating in a tank where water-lilies were cultivated. Its ability to alter its contour is not great; except to take a spherical form, it has not been seen to change.

But one individual has come to my notice with the flagellum bearing the knob-like dilatation as represented in fig. 37. It is probably a variety only, as essentially the same organism occurs with the usual lash-like appendage. This addition to the flagellum appeared to interfere in no way with its movements, which however, were not quite so rapid as in the ordinary form, the bulb remaining indistinctly visible at all times. The contractile vesicles pulsate alternately, each at an interval of thirty seconds. It may not be amiss to here state that I have also taken a single individual *Trachelomonas volvocina*, Ehr., with the flagellum distally bulbous. Whether the form was a local variety remains to be determined. In this instance the flagellum was voluntarily separated from the body, and the zooid became apparently encysted within the lorica. *Euglena viridis*, Ehr., with a bulb-bearing flagellum occurs in English waters.

FIG. 37.
MONOSIGA
ROBUSTA.

ing and sub-acute posteriorly, anteriorly somewhat constricted immediately below the origin of the collar; length one and one-half times the width; pedicel slender, rigid, the length three to four times that of the body; contractile vesicles two, posteriorly located. Length of the body $\frac{1}{2500}$ inch. Solitary. Habitat.—Fresh water, attached to the rootlets of the same floating plant with the preceding.

It affords me pleasure to dedicate this graceful little creature to my friend Miss Mary J. Wood.

M. longipes, n. sp.—Body gibbously ovate; length once and one-half to twice the breadth; pedicel slender, rigid, long, its length six to seven times that of the body; collar exceeding the zooid in height. Length of the body $\frac{1}{2500}$ inch. Solitary. Habitat.—Fresh water, attached to an alga growing in the Delaware and Raritan Canal.

Remarkable for the great length of the foot-stalk when compared with that of other species, and for the height of the collar. A favorite habit of the animalcule seems to be the protrusion of the body-sarcode into short, tapering processes extending as a series circularly about the zooid just below the beginning or origin of the collar.

CODOSIGA.

FIG. 38.
MONOSIGA
LONGIPES.

C. dichotoma, n. sp.—Bodies subspheroidal or shortly ovate, stationed sessilely to the extremities of a stout, rigid, dichotomously branching foot-stalk composed of a main rachis two or two and one-half times the length of the body of a single zooid, attached to the basis of support and furcately

dividing to form two pedicels, each five to six times a single body in length; both of these pedicels also forking to produce the four secondary pedicels supporting the zooids, and four to five times the length of one of the latter. Height of the bodies $\frac{1}{2400}$ to $\frac{1}{20000}$ inch. Total length of the branching foot-stalk twelve to fourteen times that

C. longipes, n. sp. — Bodies gibbously and shortly ovate, stationed singly on the extremity of a short, independent, secondary pedicel terminating a slender and extremely long primary foot-stalk, eighteen or twenty times the length of the body of a single zooid whose height is once and one-half to twice the width. Contractile

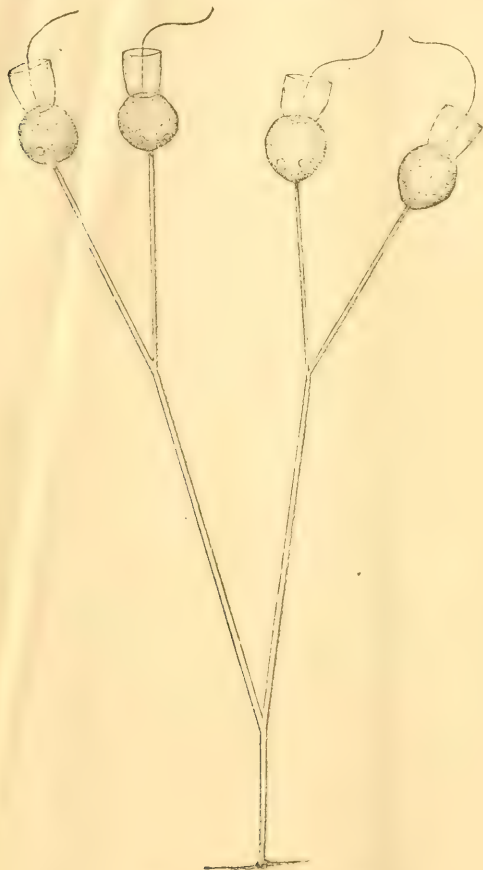


FIG. 39.—*CODOSIGA DICHOTOMA*.



FIG. 40.—*CODOSIGA LONGIPES*.

of a single body. Habitat. — Fresh water, on *Myriophyllum*.

In the only colony of the species seen (Fig. 39) the zooids were attached singly to the secondary pedicels and were four in number, while the whole foot-stalk was evenly and beautifully dichotomous.

vesicles two, as usual; pulsating once in twenty seconds. Habitat. — Fresh water, on *Myriophyllum*.

Noticeable on account of the great length of the primary pedicel, only a part of which is represented in fig. 40, the omitted portion being replaced by an interrupted line. If delineated

ever, occasionally met with a form in proper proportional height and under an amplification corresponding with that of the other parts of the figure, the foot-stalk would be about five inches long.

SALPINGŒCA.

The known pedicellate salpingœcæ having a fresh-water habitat are few, Kent describing four only, of which but one, *S. Boltoni*, S. K., seems to have been collected in British waters: while from this country, excepting the one marine and two aquatic species discovered by H. James-Clark, none of the genus have, so far as I am aware, been recorded; yet they are not uncommon on the aquatic plants of our still waters. *S. amphoridium*, J.-Clk., *S. fusiformis*, S. K., *S. gracilis*, J.-Clk., can be collected almost at a moment's warning, and a pedicellate form, apparently undescribed has recently come to my notice in some abundance, which, on account of the well-marked acumination terminating the lorica posteriorly, I have named *Salpingœca acuminata*.

S. acuminata, n. sp. — Lorica vase-shaped, widest at, or immediately behind, the median line, thence posteriorly acuminate and tapering to its junction with the pedicel; anteriorly evenly narrowing to form an everted and somewhat constricted neck, about one-fourth the height of the lorica; pedicel slender, its length once and one-half to twice that of the sheath; the contained zooid taking the form of the lorica, having an anterior, narrower neck-like portion, and being somewhat inflated posteriorly when not completely filling the lorica; nucleus anterior, sub-central. Lorica $\frac{1}{500}$, zooid $\frac{2}{500}$ of an inch in height. Habitat. — Fresh water, attached to *Myriophyllum*. Solitary, or one or two together.

The species, so far as the shape of the lorica is concerned, resembles the sessilely attached fresh-water animalcule *Salpingœca fusiformis*, S. K., but is excluded from the section to which Kent has relegated the latter, by the

possession of the pedicel. The likeness of the two forms is made still more conspicuous by the marked tendency of the body-sarcode of each to exude beyond the anterior margin of the lorica. With the animalcule figured (fig. 41) it is frequently seen extending in a tongue-like manner into the space bounded by the collar, or projecting as a colorless globule, the collar and flagellum having been absorbed. In several instances a sarcode sphere was formed and remained for an hour or more connected with the zooid only by a delicate thread, the animalcule to all appearance being about to undergo the reproductive process by transverse fission; but the filament was eventually thickened by a flow of protoplasm from the extruded globule, the whole then becoming a lobate projection which was finally withdrawn into the lorica. This was more than once repeated by the same restless individuals. Although the species does not seem uncommon, at least not in my pickle-jar-aquarium, where it has increased and multiplied and replenished the waters, one seldom appears with the sarcode filling less than two-thirds of the cavity of the lorica; and often while under observation the animalcule mysteriously increases in substance until it bubbles over in front, and at times even occupies the posterior hollow acumination.

The pulsating vesicles contract about once in eighteen seconds.

Among the pedicellate species occurring in salt water, the one to which the form here figured and referred to bears closest resemblance, is *Salpingœca urceolata*, S. K. It is distinguished not only by habitat, but by the more spindle-shaped contour of the lorica, the less sudden constriction anteriorly, and the absence of the characteristic elasticity of the neck. I have, how-



FIG. 41.
SALPINGŒCA
ACUMINATA.

that may probably be considered a fresh-water variety of *S. urceolata*, the two agreeing in essential characters, excepting the possession of the elastic neck of the sheath; but more careful study may yet demonstrate the existence of even that peculiarity. My impression is that *S. urceolata* is no more restricted to sea-water than is *Thuricola valvata*.

Having, in early spring, also collected *Salpingoeca fusiformis*, S. K., from a very small and shallow pool that speedily evaporated, it may be worth recording that the lorica of each individual was attached to the confervoid filament through the medium of a conspicuous disk-like enlargement, and not directly by the acute tip of the sheath, as figured by the latest authority on the subject. It has not been found elsewhere and was probably a local variety. A form corresponding with Kent's description and figures is not rare.

TRENTON, N. J.

A New Vorticella.

BY DR. ALFRED C. STOKES.

Though there are already thirty-nine species of Vorticellæ, it is necessary to make the number an even forty by the addition of a presumably undescribed form that I have recently found in some abundance. On account of its peculiar and well-developed external investment I have named it *Vorticella vestita*.

V. vestita, n. sp.—Body soft and plastic, broadly campanulate, widest at the anterior margin, constricted beneath peristome border and posteriorly rounded at its junction with the pedicle; when contracted, subspherical. The whole cuticular surface is covered by a conspicuous cellular coating which gives the superficial aspect a minutely reticulated appearance, and the external margin a finely crenated outline when seen in optical section. This investment is formed of a single layer of cells arranged in

equatorial series, the upper and lower cell-walls being equidistant in each row throughout the whole length of the body. The cells themselves are as colorless as the animalcule and as transparent, their contents being invisible liquid usually containing many dark-bordered, actively moving granules. When the creature is in a weakened or dying condition the cell contents are so increased in quantity that the cells become extended and bubble-like, the zooid then resembling a mass of froth.

The peristome border is but slightly everted. The vestibular bristle is well developed and conspicuous. The contractile vesicle pulsates at intervals of twelve seconds. The nucleus is band-like, curved, and remarkably long, one arm extending across the body anteriorly for almost its entire width, then bending and curving for nearly an equal distance along the ventral side of the zooid.

The pedicle is from six to seven times the length of the body, and when retracted forms about seven coils which exhibit transverse striations or wrinkles, particularly noticeable as it is extending. The muscular thread is roughened at irregular intervals by clusters of minute, rounded elevations.

Body $\frac{3}{16}$ inch in height.

The species has thus far been taken from but one locality, on an alga growing in the Delaware and Raritan Canal, near this city.

TRENTON, N. J.

Statoblasts of the Fresh-water Sponges.*

BY B. W. PRIEST.

Having lately been engaged in examining the statoblasts of the species of fresh-water sponges at present known, and being struck with their marvellous structure and beauty, I

* From *Journal of the Quekett Microscopical Club*.

thought a few words about them might interest some of the members of the Quekett Club, although I know the two British species have been ably treated by Mr. Waller.

I shall not enter into the general structure of the different species now known, but confine myself to the statoblasts of the typical specimens of each genus, noting any particular deviation of form that may occur as we proceed, and mentioning any peculiarity in the form of those sponges in which the statoblasts are unknown.

The fresh-water sponges were first made known as far back as 1696, and in 1745 Linnæus described two species under the respective names of *Spongia fluviatilis* and *Spongia lacustris*, mentioning at the same time the presence of the small seed-like bodies generally associated with them.

These organisms have been named by different writers on the subject at various times, gemmules, ovules, ovisacs, spherules, capsules, and lastly statoblasts or winter eggs, from their close resemblance to the statoblasts of the fresh-water bryozoa, not only in outward appearance but also in their being, according to Mr. Carter, similar in general internal structure, the difference being only in size and form, in having spicules instead of tentacular appendages on their surface, and in the mode of discharging their contents when matured.

Now, as there have never been any forms found in the marine sponges at all resembling the statoblasts found in the fresh-water sponges, a sharp line of demarcation between the two is here indicated by that circumstance alone.

The reason assigned for the Statoblasts occurring only in the fresh-water and not in the marine sponges is, that the former is often left high and dry for weeks, perhaps for months together, whilst the sea is constantly returning to cover the latter, they therefore do not require the protection to the ova from the influence of the atmosphere and other causes that the fresh-water sponges would do.

The statoblasts may be found most abundantly at the base of the sponge towards the autumn or winter, but in the warm summer days they are plentifully diffused throughout the entire body of the sponge, excepting, perhaps, quite the new growth.

The late Dr. Bowerbank placed the *Spongilla* under the genus *Isodictya* on account of the skeleton structure agreeing so perfectly in the form of the spicules composing it, though distinguished from that genus by the peculiarities of the reproductive organs, viz., the statoblasts, the *Spongilla* reproducing its kind after the manner of the marine sponges, that is to say, by ova proper, and division of the sarcode.

The two British species were the only ones known as fresh-water sponges, until, in 1848 and 1849, Mr. Carter published his interesting "Memoirs on the Sponges found in the Bombay Tanks," which memoir will be found in the *Annals of Natural History* of those dates. Since then new forms and varieties have been met with in Europe, Asia, and America, but strange to say, none have as yet been brought from Africa, although no doubt they exist there.

Describing the statoblast generally, it is about the size of a large pin's head, varying in this respect not only with the species, but in the individual, and can be seen with the unassisted eye. In form it is more or less globular or oval, having a foramen or hilum, either lateral or terminal on the surface, generally at the bottom of an infundibular depression which leads to the interior.

If we make a vertical section with a sharp, thin knife, through the aperture of one of these bodies when dry, we shall observe that it consists of an internal globular cavity, filled more or less with a soft, waxy substance, of a yellowish color, which substance, when swollen out in water, will be found to be composed of a great number of thin, transparent sacs, somewhat spherical, filled respectively with

minute germinal matter, consisting of transparent germs of different sizes, the whole enclosed by a delicate investing membrane, slightly protruding at the aperture, and presenting a reticulated appearance like that of vegetable cell structure. Next comes a comparatively thick, chitinous membrane, of an amber color, which, when viewed in the whole statoblast, has a deeper color than when separated. Then comes another coating or crust which, in two instances, is composed of cell structure, hexagonal in section, but in the rest of a white granular or micro-cellular substance, which can only be seen by a very high-power object-glass. It appears to afford a floating property, like cork, to the statoblast, and varies much in thickness according to the species. Its composition is still, I believe, a disputed point, Meyen thinking it was lime, having a cellular formation, but in no case has it been known to effervesce when brought into contact with hot or cold acids. This crust is charged or accompanied by spicules of different forms, variously arranged according to the species, and on which the classification of the fresh-water sponges is now founded.

Although the statoblasts have been known so many years, Johnston, in his description of the British species, does not mention the presence of spicules except in a foot-note, stating that Meyen, in 1839, discovered birotulate spicules, and others with minute spines on their surface, evidently believing, at that time, that the two belonged to the one species of sponge; perhaps a natural conclusion to have come to then, as the two were, and are often, found growing together in the same locality, and the microscopical appliances for seeing them were not then anything like so perfect as they are now. In some species, as in *Tubella reticulata*, the statoblast is enclosed in a distinct layer of spicules, which partake more of the character of the skeleton spicules of the sponge,

forming a capsular covering, in which it was probably developed.

We will now pass on to the classification of the fresh-water sponges, as founded by Mr. Carter on the form and structure of the statoblasts, as far as present known, omitting for brevity the general structure of the sponge, as I mentioned at the commencement of this paper.

The first genus comprises the *Spongilla*, containing ten species, whose statoblasts are globular, crust thick or thin, and in some cases absent altogether, accompanied by minute acerate spicules, smoothed or spined according to species.

In *Spongilla Carteri* the spicules are smoothly acerate, and the crust is composed of pyramidal columns of dodecahedral or polyhedral cells, hexagonal as seen in section or when focussing for the surface, regularly arranged one above another in juxtaposition, perpendicularly to the outside of the chitinous coat. This species has only been found as yet in India, Mauritius, and lately by Dr. Margo of Buda Pest, in Europe, in the lake of Balaton. My own specimen, for which I am indebted to Dr. Matthews, comes from Jheels, opposite Benares. The only British species of this genus is *Spongilla lacustris*, the statoblasts of which have the spicules more or less curved, minute, stout and sharp-pointed. They are covered with stout, recurved spines, the outer crust being composed of micro-cellular structure. This species is found growing somewhat plentifully up the Thames, at Henley, Goring, and Marlow, and is also met with in Europe generally, North America, and Asia, but the finest specimens that I have seen have come from the Upper Thames.

The remaining eight species of this genus are *S. alba*, *S. paupercula*, *S. cinerea*, *S. cerebellata*, *S. navicella*, *S. multiforis* (so named on account of having several openings to the statoblast; this species is also apparently devoid of a crust), *S. Lordii* and *S.*

nitens. This last-named species has the pyramidal columns in the outer crust, like *S. Carteri*, all other species having the granular or micro-cellular structure.

The next genus is *Meyenia*, after Meyen, who first discovered the presence of bi-rotulate spicules characteristic of this genus, and it comprises eight species. The statoblasts are globular or oval, the micro-cellular structure of the crust being charged with bi-rotulate spicules, that is, spicules which consist of a straight shaft terminated at each end by a disk, even or denticulated at the margin, arranged perpendicularly around the chitinous coat, so that one disk is applied to the latter, while the other forms part of the surface of the statoblast.

In *Meyenia fluviatilis* (*Spongilla fluviatilis* of Bowerbank), the species most generally known, and in which many varieties occur, as instanced in Mr. Waller's paper on that subject,* the umbonate disks are deeply and irregularly denticulated, and the shafts in some cases more or less spiniferous. The Bombay species, *S. Meyeni*, and the river Exe species, *S. Parfittii*, have both kinds of spicules, viz., smooth and spined, proving that they are only varieties of *M. fluviatilis*.

In *Meyenia plumosa* (perhaps the most beautiful of any of the fresh-water sponges as a microscopical object), the statoblasts are oval, with the aperture lateral, the umbonate disk is of equal size and the margin is irregularly denticulated, with the processes more or less turned inwards. The shaft, is long, straight, and sparsely spiniferous, the spines being large, conical, and perpendicular on their surface. I may mention here, that it is the only species of fresh-water sponge that has the flesh spicule stelliform, consisting of a number of arms of various lengths radiating from a smooth, globular body, the arms spined throughout. This species comes from Bombay.

The remaining six species are, *M. erinaceus*, *M. Leidii*, *M. gregaria*, *M. Capewelli*, *M. Baileyi*, and *M. anonyma*.

We now come to the genus *Tubella*, signifying a little straight trumpet, so named on account of the spicules charging the crust of the statoblast, having the shaft passing, by a trumpet-like expansion, into a disk at one end, this disk being larger than the other.

The statoblast of this genus is either globular or elliptical, the aperture lateral or terminal. It comprises four species, *Tubella reticulata*, *T. paulata*, *T. spinata*, and *T. recurvata*. The typical species, *T. reticulata*, has the statoblast elliptical, ovoid, aperture terminal, crust composed of micro-cellular substance charged with inequibi-rotulate spicules, consisting of a straight shaft passing by a trumpet-like expansion into the larger disk, with two or more spines about the centre, and furnished with a ring-like inflation towards the disk, which disk is circular, smooth, with an even margin, somewhat recurved, the opposite end of the spicule consisting of a circular umbonate head, regularly denticulated on the margin, with six or eight conical processes. The spicules are arranged perpendicularly, so that the small end forms part of the surface of the statoblast, whilst the disk rests on the chitinous coat. It is in this genus that the statoblasts seem to have been developed in a capsular covering composed of spicules similar to those forming the skeleton of the sponge, which are bent, subfusiform, and rounded at the ends, only half the size and more thickly spined. This species comes from the river Amazon.

The remaining genus of which we know anything of the statoblast, is named *Parmula*, a little round shield, on account of the form of some of the spicules. There are two species, *P. Batesii* and *P. Brownii*. Taking *Parmula Batesii* as the typical species, we shall see that the statoblast, besides being a beautiful object when magnified, is very curious in the arrangement of its spicules. It is large,

* ("Q. M. J.," Vol. v. p. 53.

globular, and more or less tuberculated. Crust very thick, composed of micro-cellular structure, which grows out through the interstices of the reticulated arrangement of the skeleton spicules, and forms somewhat of a capsular covering to the statoblast, as in *Tubella*, giving it the tuberculated appearance just mentioned. It is charged with, and surrounded by, minute, thin, curved, fusiform, gradually sharp-pointed, spinous, acerate spicules, irregularly dispersed through the substance, limited, both inside and outside, by a layer of parmuliiform spicules, the former in contact with the chitinous coat, and the latter on the free surface of the crust, giving it a light-brown color. The parmuliiform spicule is circular, flat, infundibuliform, terminating in a point, like a little round shield turned up at the margin, which is even. The spicules are arranged both internally and externally in the statoblast in juxtaposition, more or less overlapping each other, with the funnel-shaped process outwards in both instances, so that the surface is covered with little points.

The sponges comprising *Tubella* and *Parmula* possess an extremely rigid reticulated structure, as also the next and last genus, *Uruguaya*, so named from having been found in the rapids of the river Uruguay. The only species is *U. corallioides* of which the statoblast has not yet been discovered.

Dr. Dybowski has, I believe, found sponges in lake Baikal, in Central Asia, including a new genus, *Lubomirskia*, comprising four species with their varieties, but the statoblasts were absent in all of them. Without taking these into consideration, we have thus five genera of fresh-water sponges, including 24 species, in only one of which the statoblast is unknown. Two only of these have been found in the British Isles, varying in structure according to locality, etc. It would not surprise me if other species should be found some day, particularly as they seem to have existed in former years

in larger numbers of species, as proved by the presence of the amphidiscs and spicules found in fresh-water deposits, many of which are different in form from those at present known.

Referring to what I stated at the commencement of this paper, that statoblasts do not occur in any known marine sponges, I have been asked occasionally, "What then do you call the bodies found in *Geodia* and *Pachymatisma*, and termed by the late Dr. Bowerbank ovaria?" My answer is that they are certainly not ovaria. Dr. Bowerbank was evidently misled by the depressions which are found to exist in these bodies. If we break up any of them, as I have often done, from their earliest form of development we shall find that it is merely a depression and not an aperture leading to an internal cavity, as no such cavity exists, and that the "globular crystalloids," as they are now termed, are consolidated aggregations of spicules radiating from the centre to the circumference, and forming one solid mass, being no more ovarian than the stellate forms of spicules found in *Tethya*, or the silicious or calcareous bodies found packed in the cells of some of the tunicated ascidians. Dr. Bowerbank's statement of their being ovaria, moreover, is not borne out by the figures intended to illustrate what he says. For further particulars, a paper by Mr. Carter in the *Annals of Natural History* for July, 1869, containing remarks on the same subject, may be consulted.

Since writing this, Mr. Carter has kindly sent me a copy of his paper in the *Annals of Natural History* for the present month, describing a new species from Bombay, *Spongilla Bombayensis*; and also calling attention to one shortly to be published and described by Mr. Potts of Philadelphia, found at Chester Creek, *Spongilla segregata*, the statoblasts of which are developed in a capsule, four together; the capsule being composed of hexagonal cells, such as are found in *S.*

Carteri and *S. nitens*; the whole reminding one of the appearance of the tetrahedral form of the sporangium in certain plants.

Perhaps I ought not to leave the subject without making some statement as to the way the young sponge is produced from the statoblast, but as I unfortunately have not seen the process myself I may be allowed to quote Mr. Carter, our present great authority on the subject, as briefly as I can:—

"In due season the cellular contents are discharged through the foramen into the water, and undergo a remarkable development, appearing as a white flocculent substance, having a flat, transparent, irregular margin, containing numerous vesicles, whilst in its central portion are ova-bearing or reproductive cells. At the same time generally two kinds of spiculæ appear, which are formed in the interior of special nucleated cells. They at first present themselves as delicate lines, but rapidly grow by external additions until they attain full dimensions. These additions are generally made more quickly at one point than another, rather than throughout their entire length, so that in their half-developed condition they present one or more bead-like inflations, which disappear when the growth is complete.

"When the growth of the sponge-mass has made some progress, the formation of a distinct investing membrane out of what was the flat transparent border, becomes obvious. This membrane is gradually detached from the central ova-bearing cells, either by the shrinking of the latter, or by the protrusion of bundles of spicules which force it outwards, leaving here and there open spaces between the membrane and the central cell-mass.

"And so it proceeds until after the development of other spicules and canals formed for the passage of the water, the sponge is perfected and continues to grow by adding to its

general structure, until it arrives at its full size, which, of course, varies according to the locality and species.

"The process best suited for examining the structure of the statoblasts in the dry state—which is the most easy method, many difficulties attending the examination fresh, when attainable—is to place four or five on a glass slip with a drop of strong nitric acid. Boil this to dryness over a very low spirit lamp. Do this three times. Then place the slip on the incline and pass water over it with a camel's-hair pencil until all the remains of the acid is washed out. Next with a sharp, thin knife like a lancet, divide, in half or in quarters, one or two more statoblasts, and adjust them round the remains of the foregoing (or on a separate slip if you prefer it). Add a drop or two of benzole or turpentine to keep them in place, and when dry, which will be in a few minutes, add a drop of Canada balsam, cover with thin glass, previously just warming the cover, put the slide in a warm place for some hours to harden, and it will then be ready for examination."

Artificial Oyster Culture.

The following paragraphs are taken from *Forest and Stream*, and possess much interest to microscopists:—

"Mr. J. A. Ryder, a special assistant of the U. S. Fish Commission, announces that he has successfully reared the American oyster from the egg at Stockton, Worcester county, Md., on the grounds of the Eastern Shore Oyster Company, during the past summer, Messrs. H. H. Pierce and Geo V. Shepard, of the above firm, kindly placing all facilities at the disposal of Mr. Ryder for carrying out his work and afterward continuing the experiments under his direction. The apparatus was as simple as could possibly be devised in order to insure success, and was perfectly automatic in its action. A pond was excavated

in the salt marsh, near the shore of Chincoteague Bay, and connected with the latter by a trench about ten feet long, two feet wide and three feet deep. Before the water was let into the pond a wooden diaphragm, made with perforated boards lined with gunny cloth, and filled with clean beach sand, was placed in the ditch and so secured that absolutely no water could get into the pond from the bay except such as filtered through this diaphragm. The rise and fall of the tide alone was depended upon to change the water in the pond, and it was found to rise and fall from four to six inches during every tide, ebbing and flowing slowly through the diaphragm. The rise and fall was found not to be as great in the pond as in the open bay, but was sufficient, as the sequel has shown. The inclosure so arranged constituted the whole of the apparatus, if it could be called such, designed to confine the artificially fertilized spawn.

"The spawn was taken from the adults by a method originally devised by Mr. Ryder, and already described in various published reports and papers. After the spawn was taken it was allowed to stand in pails with an abundance of clean water for a period of three to five hours, so as to give the oyster eggs a chance to develop to the swimming condition. It was then poured into the pond or inclosure at various points to insure its effectual distribution through the water. Stakes were then driven into the bottom of the pond, to which dead oyster shells were suspended on wire; the stakes put down at different dates being marked so as to distinguish them apart. The suspended oyster shells were introduced so as to afford the young fry clean surfaces to which they could fix themselves. The first spawn and shell collectors were put into the pond July 7th, and some of the shells were found by Mr. Pierce, on Aug. 22d just past, to have spat attached ranging from a fourth to three-fourths of an inch in diameter. Some

samples of these young oysters are now in Mr. Ryder's possession, proving conclusively that oysters may be reared in inclosed ponds such as here described, in which it has also been found that the natural food of the animal is produced in vast quantity.

This experiment has been so conducted as to preclude any doubt that the spat obtained has been derived from any source except that of the spawn artificially fertilized and introduced into the inclosure. It also marks the most important step that has yet been made in this country in oyster culture. The methods are likewise so simple that they are available in the hands of unskilled persons. A full description of the methods pursued will shortly be published in the Reports of the United States Fish Commission."

Young Oysters.

It is said that the American oyster in its larval or embryonic condition, escapes from the parent devoid of any shelly covering, swims about by means of cilia for a short time, and then settles down for life. The British oyster in its young stage is less venturesome, for it remains within the mother shell until its own shell has formed, when it swims away and soon becomes attached for future growth. The young oysters, with their delicate, transparent shells, and cilia projecting between the valves incessantly lashing the water, are interesting objects under the microscope, but they are not to be found in the American oyster. In England they may be found in great abundance during August and September, in the oyster spat, which appears as a dark-grey, slimy mass running from the shell of the mother oyster. By separating the two valves the spat may be run off into bottles, and in clean salt water the embryos will live for a considerable time. To most microscopists in this country the minute shells of the embryos are only

known from the preparations sold by the dealers in foreign slides. These are not very widely distributed, and as the mounted shells are not only instructive as illustrating the development of the oyster, but also very beautiful objects, the editor of this JOURNAL has obtained a small quantity of the spat, and preserved it in fluid for distribution among the subscribers to the JOURNAL.

It was rather late in September before the idea to do this occurred to him, and for this reason the quantity obtained was less than would be desirable for this purpose. However, a plan of distribution has been devised which will doubtless enable all subscribers who desire specimens to obtain enough for several slides. Mrs. Hitchcock has kindly offered her assistance in distributing the material, so that the editor will be relieved of the necessity of giving personal attention to it. Subscribers who desire to receive specimens are therefore requested to address Mrs. R. Hitchcock, post-office box 630, Washington, D. C., enclosing a three cent stamp, to cover the expenses of return postage. They will receive in return, as soon as the material can be properly cleaned and divided for distribution, a sufficient quantity for several slides of the best quality.

The young oyster shells resemble minute, transparent, and perfectly formed clam shells. They are beautiful objects for the microscope however they may be mounted, but there are three ways to be recommended, as giving a variety of effects. To have the shells perfectly clean it is well to wash them with clear water before mounting them. Then proceed as follows:—

To mount them in balsam select a clean slide, place a drop of the water containing the shells on the centre, let the water evaporate, and apply thin balsam in the usual way, avoiding pressure on the coverglass. Specimens mounted in balsam make fine objects for the polariscope. Perhaps

the dry-mounted shells are most frequently met with. To mount them dry, make a shallow cell with an opaque, black ground, and place upon the latter some of the shells in a drop of water. Add to the drop the least trace of gum from a very dilute solution of gum Arabic in water. When this is mixed with the drop, draw off the excess of fluid with a camel-hair brush, and allow the shells to dry thoroughly. The small quantity of gum left will cause them to adhere well to the bottom of the cell. The cover may then be applied.

Frequently the young shells are mounted in fluid so that they may freely move about when the slide is inclined. They then make very beautiful objects for the polariscope, as they roll about in the liquid when the slide is examined on an inclined stage. The cell should be deep enough to let them move freely. A shellac cell will do very well, and water is a good medium to mount them in.

EDITORIAL.

ALL communications relative to business matters, should be addressed to the publishers, S. E. Cassino & Co., 41 Arch Street, Boston, Mass.

CONTRIBUTIONS, exchanges, and letters pertaining to the editorial management, should be addressed to the Editor, P. O. Box 630, Washington, D. C.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. Subscriptions begin with the January number, unless otherwise ordered. Address, S. E. Cassino & Co., Boston.

EXCHANGES.—Publishers and editors who favor us with their publications in exchange are requested to note the change in the editor's address. All exchanges and books for review should be addressed to the editor, Post Office Box 630, Washington, D. C.

HOME AGAIN.—After an absence in England, unexpectedly prolonged, the Editor has returned just in time

to read the proofs of the present number of the JOURNAL. It has been fortunate both for him and for the subscribers that his brother, Harlyn Hitchcock, has been able and willing to attend to many details connected with the business and editorial conduct of the JOURNAL since July, which was the time of our expected return. It is to his kind and opportune assistance that the prompt issuing of the JOURNAL each month has been, in a great measure, due.

Having once more assumed immediate supervision over the publication of articles contributed by our numerous correspondents — the number of which, we are pleased to observe, has been steadily increasing during our absence — we hope to make the JOURNAL of still greater value and interest than it has been in the past. The opportunities seem greater now than ever before, partly because of the favorable circumstances for the work afforded by the editor's connection with the National Museum, where the comprehensive library at command greatly facilitates scientific work of any kind, and partly for other reasons.

Correspondents will please observe the change of address advertised above.

THE FRESH WATER SPONGES.—The interesting article by Mr. B. W. Priest, which we publish this month, on the statoblasts of the fresh-water sponges, affords a good starting-point for the microscopist who desires to pursue a course of investigation. The author of the paper referred to has given a very full and clear summary of the work already done in this field, although there are a number of species of fresh-water sponges not uncommon in this country, but only recently described, which probably escaped notice when the article was prepared. The reader may find references to, and brief descriptions of, the American forms by looking over the indexes of the last two volumes of this JOURNAL.

Sponges can be found in many waters where their existence is not suspected, if one will take a little trouble to look for them at different seasons. They occur in rapid streams, and in ponds. In the former they grow attached to stones and may be easily detected, in shallow water, by their green color. In ponds they are often found on sticks and twigs brought up from the bottom, or growing on the stems of water-plants, the leaves of *Vallisneria*, etc.

In reference to the preparation of sponge-skeletons for microscopic specimens we have already several times alluded to the use of Javelle water for removing the soft parts, leaving the spicules in their natural position. We have not yet given it a trial, but are hoping for an early opportunity to do so. Unfortunately we have not been able to obtain specimens of fresh sponge to experiment with; for, although common enough at times, sponges are not to be found in the same places at all seasons. Meanwhile microscopists who live in the country, with streams or ponds near by, may find the inclination, as well as the opportunity, to test the process, when we would be pleased to publish their conclusions.

PLANT-CELLS IN ANIMALS.—It has been said that animal life is entirely dependent upon plants, both for food and oxygen. Among the higher orders of life the physiological processes take place independently, and their mutual interdependence is only observable after long study and investigation. It is now well understood that the higher plants, under the influence of light, absorb and decompose the carbonic acid gas which results from the respiration of animals, giving out pure oxygen in return, which supports animal life. The plant also prepares the food of the animal out of the inorganic constituents of the air, water or earth. One of the most important products of the veg-

etable world is starch. Starch is never produced by animals, or at least its production in the animal world must be regarded as extremely doubtful. It is a characteristic of vegetal life, and forms an important source of nutriment to the animal body, being transformed into fatty matter, and consumed as fuel to maintain the temperature.

It is interesting to consider that, according to the later researches of K. Brandt, there is a like interdependence between certain lower forms of animal and plant life, manifested in those organisms, which, while they are clearly animals, possess granules or cells containing chlorophyl. It is not a new idea that the green or the yellow cells of animals may be parasitic plants, for it was long ago suggested that the yellow cells found in the radiolaria, as in the polycystina for example, and in many fresh-water rhizopods also, might be unicellular plants, and in support of this supposition it was observed that after the death of the animals the plants continued to grow. K. Brandt, however, has again taken up the subject for investigation, and he finds that the yellow cells of foraminifera, radiolaria, ciliata, sponges, and also of some higher animals, are algæ upon which the animals, especially the radiolaria, at least in a measure, are dependent for their nourishment. He concludes that the yellow cells are resting stages of certain higher algæ, especially of the melanophyceæ. Doubtless the yellow algal cells grow with unusual vigor in the animal body owing to the abundance of carbonic acid gas evolved by the animal, while the animal is in turn benefited by the starch produced by the alga and assimilated by the animal. Starch has been found free in certain collozoa, supposed to be derived from the algal cells.

FORAMINIFERA IN CHALK.—Mr. M. C. Cooke has lately recorded, in a paper read before the Quekett Club,

the results of some old but not previously published calculations of his own, on the number of foraminifera in the Kentish chalk. He took an ounce of chalk from the pit and removed the lighter fragments by continued washing, until a sediment of nearly pure foraminiferal shells was obtained. Half of this was cleaned by boiling in caustic potash and ultimately there was found enough material to mount 100 slides of 1000 shells on each. An ounce of the chalk, therefore, yielded 400,000 shells. In another experiment, more carefully conducted, upwards of half a million shells were obtained, without reckoning fragments washed away, etc. Hence the pound of chalk from which the specimen was taken contained 128,000,000 foraminiferal shells—a number which it would take ten years to count at the rate of sixty a minute for twelve hours each day. Ehrenberg calculated that there were one million and a third organisms in a cubic inch of chalk. This would be equivalent to 288,000,000 in Mr. Cooke's block, which, according to his own calculation, contained 256,000,000. These two results, obtained independently, indicate that they are quite near the truth. If each of the shells in an ounce of chalk was as large as the shell of the common garden snail, *Helix aspera*, they would form, side by side, an unbroken line 12 miles in length.

PRESERVATION OF MUSEUM-SPECIMENS.—At the International Fisheries Exhibition some fine specimens of delicate marine organisms are shown, preserved in spirit by a method adopted at the Zoölogical Station at Naples. These specimens embrace many animals which it would scarcely be supposed could be satisfactorily preserved. Among them are many of the cœlenterata almost as perfect as in life. The most delicate jelly-fishes are shown as clear, transparent, masses of jelly floating in the liquid

with tentacles waving as in life, although we believe the bodies are somewhat shrunk from life-size. *Beloe ovatus* is beautifully shown, also the delicate *Obelia geniculata* with polypes, like *Actinia*, *Acyonium*, etc., echini and salpæ.

These are, assuredly, the finest and most useful museum-specimens of the kind we have seen, as they afford a far better idea of the appearance of the living animals than can be obtained from shrivelled and distorted specimens preserved in alcohol in the usual way. Take, as an example, the suckers of the *Octopus*. Ordinarily they are seen, in alcoholic specimens, distorted and irregular in shape, while in the specimens shown at the Exhibition they have smooth, round borders, and a natural appearance.

These objects are not all microscopic, but some of them are, and microscopists who are able to obtain their specimens of hydroid polypes, or zoöphytes, and polyzoa alive, would do well to supplement their microscopic preparations of those animals with a set of specimens prepared for exhibition in bottles, to show the manner of growth, and the natural size and appearance of the living animals. Such a collection would be very attractive as well as instructive. It is well known that as such specimens are usually prepared each cup of the polypedom contains a dense, more or less, granular and opaque mass of animal matter, totally unlike what is seen in a living specimen. In the preparations referred to above the stalks seem clear and clean, and are far more attractive to the eye.

The method of killing the animals at Naples, we are told, is, in brief, as follows: The living creatures are plunged into a solution of iodine, or into a strong solution of corrosive sublimate. From either of these solutions, which seem to suddenly kill the animals and harden the soft parts, the specimens are transferred to dilute spirit, in which they are permanently preserved. We hope

soon to have more full details of the process.

NOTES.

— We are pleased to announce that at a meeting of the Royal Microscopical Society, held last month, Dr. Henri Van Heurck was elected an Honorary Fellow of the Society.

— Mr. Amos Topping, of London, who is the successor of his father in the business of preparing microscope slides, favored us with a call at the Fisheries Exhibition, some time ago, and brought with him some of his preparations, which we were much pleased to see. All workers with the microscope are familiar with the preparations for which the elder Mr. Topping has long been famous. His son continues to supply the trade and microscopists generally with preparations of his own, many of which find their way to America.

— Referring to mounted specimens of microscopic objects, we have observed that in England they can be bought much cheaper than in America; in fact the prices charged here are quite exorbitant when compared with the prices in London. Slides of the ordinary kind, well mounted and in every respect good, can be purchased in London for a shilling each, — twenty-five cents in our money. This is the ordinary retail price, when bought singly or by the dozen.

— The processes of reproduction of foraminifera are still but vaguely known. An interesting observation has been made in relation to the subject by C. Schacko, who has found within the chambers of *Peneropolis proteus*, D'Orb., taken from the intestine of a holothurian more than a hundred embryos, thirty in the last, large chamber, twenty-six in the preceding chamber, and sixty more in the other chamber. Each of the embryos was the same size as the embryonal chamber of the mother shell. They appear to have originated by segmentation of the sarcodæ of the parent.

— Prof. E. D. Cope has discovered a fresh-water hydroid, having a cœnœcium forming a mass of yellowish, creeping stems imbedded in sarcodæ. The zooids has six rays of equal length. The spe-

cies has been named *Rhizohydra flavitincta*. It was found in Upper Klamath Lake, Oregon, growing in masses as large as the fist.

— In cases where it is desirable to stain sections on the slide they may be attached to the slide by spreading a layer of one part of collodion solution and $\frac{3}{4}$ parts of oil of cloves over the slide. The sections are arranged on this layer where the oil of cloves is driven off by gentle heat. The sections are then fixed to the slide, and may be treated by various reagents and stained in the usual manner.

— In some experiments on pathogenic bacteria, by A. Chauveau, it was found that at a temperature of 47° c. the bacteria of cattle distemper entirely lost their infectious properties, although their growth was not apparently interfered with.

— Hyacinths are subject to two distinct diseases due to the attacks of fungi, one is a so-called "yellow disease," in which, in the autumn the vascular bundles of the bulbs are permeated by a yellow slime which swarms with a bacterium that has been named *Bacterium hyacinthi*, although it closely resembles *B. termo*. In the spring the bacteria also infest the vascular bundles of the leaves. The other disease is known as the "black smut." This is due to an ascomycetous fungus resembling that parasitic on clover, the *Peziza ciborioides*. It may be obtained with the asci by placing the infected bulbs in a pot and watering them freely.

— Dr. Wallich announces the discovery of polycystina among the loose, fossilized contents of nodular flints from the gravel pits of Surrey. Indications of polycystina have been frequently observed in sections of flints, but the remains have not been sufficiently well preserved to establish their identity. The nodular cavities examined by Dr. Wallich contained species distinct enough for identification. The genera *Astromma*, *Haliomma*, and *Podocystis* were observed, with some others. Foraminifera of the genera *Globigerina*, *Textularia* and *Rotalia* were also found in the same cavities. We have thus a further confirmation of the evidence which indicates that the chalk is continuous with the beds of calcareous deposits now forming on the sea-bottom.

— N. Pringsheim maintains that the fertilization of *Achlya* and *Saprolegnia*

is effected by "spermatozoa" which are peculiar bodies developed within the antheridium, during the period of fertilization. These enter the oögonia and fertilize the oöspores.

— Heretofore it has been supposed that the yeast used in bread-making was the sole cause of the fermentative action in the dough. Mr. G. Chicandard thinks the function of the yeast is far less important than is supposed. He maintains that the starch is only modified by heating, and is not transformed into a soluble constituent by the fermentation. In his opinion the first step in making bread is the transformation of some of the albumenoids of the gluten into soluble products and then into peptones. The active agent in this action is, he believes, a bacterium normally developed in the dough. Whether this view is the true one remains to be seen.

— A writer in *Nature* has advised a method of freeing objects from air preparatory to mounting in glycerin jelly, etc., which was used by us years ago to free the stalks of zoophytes, polyzoa and other specimens from air, and which, we believe, has been already published in this JOURNAL. The sections are simply placed in thoroughly boiled water. Boiling expels the air dissolved in the water, and by placing the sections in such water the air is more or less taken up by the water. The process is rather a long one when any considerable quantity of air has to be removed.

— Mr. F. Von Höhmel, referring to the structure of silk fibres, mentions that each raw cocoon thread consists of two separate fibres enclosed in a smooth case known as silk-gelatin or bast, which connects the two threads of the raw silk fibre. This gelatin case is readily soluble in soap solution, dilute potash-lye, and weak chromic acid, these substances effecting a separation of the originally combined threads. The single fibre freed from the gelatin case consists essentially of fibroin, whilst the bast contains sericin. The silk from *Bombyx mori* and *Saturnia spini* has a homogeneous, hyaline, formless fibroin-thread, rarely exhibiting signs of striation. The fibre of exotic silks, now largely used on account of their cheapness, has a different constitution. It consists of a substance in which the so-called fibrils are enclosed. These are circular threads 0.0003 to 0.0015 mm. in diameter. Real silk is easily distin-

guished from foreign silks by examining it under the microscope. Its fibre is round, has a smaller diameter and is not colored very much. The author has determined the largest diameters of single threads of a number of silks with the following results:—

Real silk (from *Bombyx mori*) 20 to 25 μ
 Senegal silk (from *Bombyx Faidherbi*) 30 to 35 μ
 Ailanthus silk (from *Bombyx Cynthia*) 40 to 50 μ
 Yamamay silk (from *Bombyx Yamamay*) 40 to 50 μ
 Tussah silk (from *Bombyx Selene*) 50 to 55 μ
 Tussah silk (from *Bombyx Mylitta*) 60 to 65 μ

The following are the most characteristic color-appearances exhibited by these silks: Real silk (*Bombyx mori*), broadside, prevailing color bluish-white or yellowish-white, shining; narrow side the same. Yamamay silk (*Bombyx Yamamay*), broadside mostly a bluish-white color, with dark blue, bluish-grey, and black shades; narrow side glaring and fine colors, with dark or black shades. Tussah silk (*Bombyx Selene*), broadside the fibre is irregular in thickness; the thickest parts are covered with grey or (mostly) blue spots, whilst the thinnest parts are bluish-white, yellow, or orange-red; narrow side ground color dark grey, with pink or light green spots. Tussah silk (*Bombyx Mylitta*), broadside similar to *Bombyx Selene*, the spots, however, are colored orange-red, red, or brown; narrow side the same as in the case of *Bombyx Selene*. Ailanthus silk (*Bombyx Cynthia*), broadside shining yellowish-white, with yellow, brown, brownish-grey, or similarly colored places; narrow side ground color dirty grey or brown to black, with green, yellow, red, violet, or blue spots. Senegal silk (*Bombyx Faidherbi*), broadside shining yellowish or brownish-white, or pale yellow, grey, brown, and occasionally bluish-white, narrow side grey, brown, or black, occasionally lighter shades. In conclusion, the author mentions that he has succeeded in separating, quantitatively, a mixture of cotton, sheep's wool, real silk, and Yamamay silk into its four component parts. By boiling the mixture for half-a-minute with hydrochloric acid real silk is separated; by continuing the boiling for two minutes with concentrated hydrochloric acid Yamamay silk is dissolved, and by heating the residue with potash-lye sheep's wool

is separated, whilst cotton remains behind.—*Jour. of Soc. of Chem. Industry.*

—Several correspondents have written in response to the notice published by the editor some time ago, offering to send specimens of Barbadoes earth containing polycystina for mounting. The Editor is obliged to ask their indulgence for a short time, as the material will not be accessible until it is unpacked, being now stowed away in boxes with other microscopical specimens. As soon as possible all requests will receive attention.

—At the Annual Meeting of the Quekett Club, Dr. Matthews exhibited a new form of nose-piece intended to facilitate the substitution of objectives. It is merely a cone-fitting, without screw or catch of any kind. The hollow cone is screwed on to the stand, and the cone fitting within it to the objective. The fitting is tight enough to hold the objective securely, and it is said that the apparatus is both accurate and inexpensive.

Exchanges.

WILL EXCHANGE.—A new copy of Leidy's *Fresh Water Rhizopods* of North America, for a good half, or three-fourths inch objective. Address T. B. Jennings, Signal Office, Springfield, Ill.

FRESH-WATER ALGÆ and various pond productions in exchange for same in other places. J. M. Adams, Watertown, N. Y.

FOR EXCHANGE.—First class double-stained sections of Magnolia, Fig, Orange, Oleander, Butter-nut, Birch and many others; also fine injected specimens. N. A. Richards, St. Louis, Mich.

FOR EXCHANGE.—Slides of pollen of pitch pine, *Pinus rigida*, with the connection stained, for any named slides of algæ. Dr. C. F. Millsbaugh, E. M. S., Binghamton, N. Y.

WANTED.—*Trichina Spiralis*, *Pleurosigma* Ang., or other well-mounted slides in exchange for fine slides. Insects, Acari, Spermatozoa of Horse, Physiological and Pathological preparations. J. O. Stillson, M. D., 504 Upper Second Street, Evansville, Ind.

FOSIL DIATOMS from Carson, Nev., and Posa Creek, Cal., slides or material to exchange for good diatoms, mounted or material. Also, many other diatoms; lists exchanged. The above deposits are rich and newly discovered by myself. F. H. Engels, M.D., Virginia, Nev.

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No. 12.

About Moulds.

Sometimes when we look at the most simple organisms in existence we think they are the most beautiful. One can scarcely tell which is most wonderful, the complex structure of the higher plants and animals, or the manifestations of life in its primitive conditions. In one the various functions of life are performed by different organs, each perfectly and beautifully adapted to its purpose, in the other there are no organs, and scarcely any distinction between the outside and the inside; yet there is life in all its perfection in the merest speck of seemingly homogeneous jelly.

Imagine a forest in miniature, so small indeed, that hundreds and thousands of trees would grow in the space of a few hundredths of an inch. It would be beautiful under a microscope to see how the microscopic stems stand up from the mass of interlacing roots, and branch out in all directions at the top. A growth of some of the microscopic fungi commonly known as moulds, may be likened to such a forest. The comparison is not scientifically exact, perhaps, yet it will serve our purpose very well. The first stage in the growth of a mould is a mass of white, interlacing fibres, which spread with great rapidity all over the mouldy surface. But, perhaps the reader will say, moulds are not white,—they are blue, or pink, or black, or red. It is true that we usually do observe moulds more or less colored, but this is because we overlook them until they have matured

their fruit, which is colored. In their first stages they are white, and the part that first appears always remains white. This part is called the mycelium. The mycelium is always white, and it does not change this character at any time. It consists of a series of cells joined end to end, forming filaments. These may be compared to the roots of our miniature forest, only, instead of lying hidden beneath the ground, they often spread over the surface, forming a delicate, cottony layer, from which the trees will spring up here and there. They also penetrate into the interstices of the article on which they grow, and thus rapidly spread through it, causing it to decay.

Before going any further with our description, it will be best to tell how a mycelium for study may be obtained. It is easy to obtain a piece of mouldy bread, or cheese, or boiled potato, or some mouldy article of food. The greenish or bluish layer that forms on the surface of preserves will be excellent for the purpose. Having obtained such an article, take a slice of potato, raw or boiled, it makes no difference, or a bit of bread, and dust some of the blue mould over it, or put it against the mouldy surface so that some of the minute particles of the mould will adhere to it. Then take a small bell-glass, or a tumbler, and a saucer of water. In the saucer put a small, wide-mouthed bottle, and upon that a piece of glass, and on the glass place the potato or bread. Then line the tumbler with a strip of blotting-paper, and invert it over the saucer. The object of all this is to keep the specimen in a moist atmos-

phere, which is favorable to the growth of moulds. The blotting-paper promotes evaporation within the glass, and thus keeps the atmosphere saturated with moisture.

In a few hours the specimen, if closely examined with a pocket-lens, will be found covered with the threads of mycelium. Scrape the surface with a knife in one spot and put the scrapings on a slide, cover it with thin glass, and examine with a $\frac{1}{4}$ - or $\frac{1}{8}$ -inch objective. The structure of the mycelium will then be clearly made out. Now let the mould grow until it begins to show itself by its color, which will probably be bluish, as the most common mould is the blue mould.

Another way of cultivating a mould for examination is to make a rather strong solution of gelatin in warm water, and spread a thin layer upon a glass slip. The gelatin sets in a clear, transparent film upon which the fungus will grow very rapidly in the moist chamber. This method presents the advantage that the growth takes place on a transparent surface, which facilitates examination under the microscope.

If the mould be examined just before it is seen to change color, using a power of 150 diameters or more, there will be found numerous upright threads standing out from the mass of mycelium. These are fertile threads, and in the common blue mould they will be seen to terminate in distinct heads, which ripen and resolve into innumerable chains of spores, spreading outward and bending gracefully downward like the drooping branches of a tree. It is these stems, with their chains of spores, that form the trees of our forest. The spores are the fruit of the mould. Wherever they fall upon a suitable nidus for growth they reproduce the plant. When fully ripe they give the color to the mould. They are so exceedingly minute, however, that they must be examined with a power of 250 diameters. For this purpose some ingenuity must be exercised to get the mould under the

microscope in good condition for examination. Water does not readily moisten the ripe spores, and in trying to get a good view of the stems, with their chains of spores attached, the natural arrangement is sure to be very much broken up. Perhaps the best way to proceed is to carefully detach a minute portion of the mould with forceps, and lay it gently on a slide. Then moisten it with a few drops of alcohol and water and apply the cover-glass. Patience and perseverance will doubtless be rewarded by yielding a fine view of the fructification.

The fungus we have thus briefly described is the blue mould known as *Penicillium*, of which numerous species have been described. They are all characterized by the chains of spores above mentioned, growing from the head of the upright filaments. Bear in mind that the filaments bearing the fruit are distinguished as fertile filaments, and the barren ones form the mycelium.

Another very common kind of mould is known as *Mucor*. In this the fertile stems branch, and terminate in rounded heads within which the spores are enclosed. In *Penicillium* the spores are naked, in *Mucor* they are protected by a membrane. There is strong presumptive evidence that *Mucor* and *Penicillium* are different conditions in the growth of the same fungus, but this conclusion is still open to doubt. Conclusive evidence is very difficult to adduce. If a filament of mycelium could be followed in its course until it is found giving rise to both methods of fructification, the conclusion would be undeniable. At present we have only the evidence of close association to support it. If, after the *Penicillium* has ripened in the moist chamber, the plant be kept under cultivation for a time, it is very likely that *Mucor* will appear, growing up from the same nidus.

The spores of *Penicillium* may be sown in a fermentable liquid and they will grow precisely like the yeast-plant. It is, therefore, supposed that

the yeast-plant is a condition of *Penicillium*. The sporules of yeast, under certain conditions, elongate and grow into filaments, which may be the same as the mycelium of *Penicillium* growing submerged.

Fungi of various kinds may be found in the fall upon leaves of many plants, and especially upon fruits, such as grapes, apples, peaches, etc. These may be cultivated in the manner already described, and will afford interesting objects for study during the winter months, as they may be kept dormant for months, until warmth and moisture quicken them into life.

The Fresh-water Medusa.

We present our readers this month with an illustration of the beautiful fresh-water medusa which was found some time ago in the Victoria Regia tank of the Botanical Gardens, London. This delicate organism, the only one of its kind found in fresh-water, has been very abundant in the

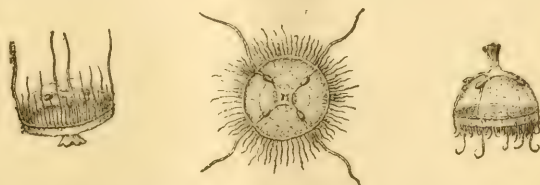
The method is to plunge the creatures into a solution containing four grains of corrosive sublimate dissolved in a pint of water, the solution being maintained at a temperature of 85° F. The bodies are rendered opalescent, but the minute details of their structure are clearly shown in the preserved specimens.

We have seen some specimens of this medusa which appeared to be well preserved, but it was said they were killed with osmic acid. Possibly this was a mistake, and that they were prepared by Mr. Squire's method. They were certainly good preparations, however made.

The Microscopical Discrimination of Blood.

By C. M. VORCE, F. R. M.S.

In the September number of this JOURNAL, editorial comment was made upon the claim of some observers to be able to discriminate human from other



Whilst swimming in the tank.

When in the preserving fluid.

FIG. 42. — FRESH-WATER MEDUSA.

tank this year. The water of the tank, which sustains tropical vegetation, has a constant temperature of 85° F., and at this temperature the great water-lily, from which the tank takes its name, grows luxuriously.

The first figure (fig. 42) shows the medusa (*Limnocladium Sowerbii*) as it appears while freely swimming. The two succeeding figures represent the same animal preserved by a method employed by Mr. P. Squire, F. L. S., and given in full in the *Journal* of the Royal Microscopical Society.

other mammalian blood, by measuring the corpuscles soaked out from a dried blood-stain, and stress was laid upon the necessity for extreme caution in reaching and announcing a conclusion in such cases.

Probably no microscopist, of more than limited experience, needs any reminder of the necessity of care and caution in such cases, but from considerable observation, and from the published results of work by many observers in the direction indicated, I cannot escape the conviction that few

adequately realize what is sufficient caution in reaching a conclusion on the subject. Nothing is more common than to see a determination arrived at simply by measuring a series of blood-discs of various kinds, and comparing the results with what is accepted as a standard size of the blood-corpuscles of various animals. Now, while this may afford a correct determination, it is very far from certain to do so. Dr. J. J. Woodward in *M. M. J.* XIII, p. 65, pointed out many of the discrepancies in the older measurements of blood, and his own measurements, recorded in the same Journal, where he describes his methods and apparatus with a particularity commonly wanting in the earlier cases, do not add any certainty to the matter. Dr. J. G. Richardson also, who, so far as any recorded observations show, has done more work on blood-stains than all others together, in his measurements of the blood of different races at the Centennial, differs considerably from the old measurements, which are, however, still quoted as standards. No longer ago than last year measurements were published, and by a good observer, in comparison with the $\frac{1}{3200}$ -inch as the standard size of human blood-corpuscles. Yet I believe few microscopists, especially if they have worked upon blood-measurements, would now accept the $\frac{1}{3200}$ -inch as very near a reliable standard of the size of human blood-corpuscles, notwithstanding the numerous so-called "authorities" which still flaunt the $\frac{1}{3200}$ standard.

Let us consider for a moment how many real authorities we have, and what constitutes an authority, on the subject. Chief among those who early made the measurement of blood-cells a study are Leewenhoek, 1673-1720; Hewson, 1773; Della Torre, 1763; Rudolphi, 1821, and several others might be named from the long list of observers up to about 1840. Then, in the middle ages, so to speak, of this subject, Gulliver, from 1840 to 1846; Robin, 1858; Schmidt, 1848; Virchow,

1857; Kölliker, Harting and Valentine before 1863; and Welcker, in 1863; contributed further data; and since the period of about 1860-63, Richardson, Mitchell, Woodward and Smith have added something to the store of measurements. Of all these and the numerous other observers, scarcely any two agree exactly in their measurement of human blood, although the variation between the most of them is very slight. Now, as to the perfection of the apparatus used, and the personal skill and accuracy of the older observers, we know but little; but what we do know is not calculated, in the light of later work, to inspire confidence in the reliability of their measurements as compared with the later ones. Of the grave defects in the methods of Gulliver, Welcker and others, some were pointed out by Dr. Woodward in the paper cited; and inhering in all the measurements back of about 1850 is a considerable liability of error arising from too low powers and inferior corrections of the objectives, and too indefinite value of the micrometer rulings used. This liability of error has been reduced to almost nothing by the perfection attained in objectives and micrometers of late years.

In most of the text books commonly used as "authority" on the size of blood-discs, we still find the older measurements stated as the standard, and almost without exception entirely unverified by the author! The "Micrographic Dictionary," intended to be an authority on matters purely microscopical, gives (3d Ed.) Gulliver's measurements; Carpenter and Flint, in the language of Dr. Richardson, "follow Gulliver," and so authors have gone on following Gulliver until the $\frac{1}{3200}$ -inch has even acquired the title of classic as the standard size of human red blood-corpuscles. Ask an expert for the authorities on the size of blood-discs, and he will reel off a string of names of authors "following Gulliver" to the number of a dozen or more, and will call them a dozen "authorities," while in fact they

are all but one authority, and that one is Gulliver.

Therefore, I claim that microscopists should abandon the $\frac{1}{3200}$ -inch as a standard, and should determine a new standard by means of the best modern appliances, and I venture the opinion that such a standard will be found to be nearer to $\frac{1}{3400}$ -inch than is generally suspected. But most especially do I object to careful measurements made at this late day being compared with the $\frac{1}{3200}$, or any of the old reported measurements, to determine the character of the blood measured. If a comparison is to be made let each microscopist make his own comparison directly, by measuring the things to be compared with the same apparatus, and this comparison he can rely upon with full confidence, while he can not so rely upon a comparison of his own measurement of one with somebody else's measurement of the other.

Late measurements of several thousand corpuscles of various bloods under various conditions in which I have participated with a fellow-worker, have convinced me of the danger of reliance upon "authorities" in this matter if a correct result is to be hoped for. In a future number I may communicate some of the very interesting facts observed. In the meantime, as bearing upon the subject, and setting forth fully my views of micrometry in general in relation to minute objects, including blood, I state the following propositions as being generally and with rare exceptions true, to wit:—

1. Different observers, using the same apparatus and viewing the same object, will almost invariably differ slightly in their measurements of it. Between some observers the difference will amount to nearly five per cent, of the lesser measure, when using powers of 1500 or upwards.

2. The lower the magnifying power used the greater will be this individual error, in proportion to the actual size of the object.

3. Measurements made by one observer, cannot, as a rule, be accurately

compared with those of the same object made independently by another observer, even if similar apparatus and powers are used by both; while if different apparatus and powers be used the comparison becomes much less satisfactory, and is practically of but little value.

4. Even when the errors of the respective micrometers and apparatus and the personal equation of the respective observers are known, such measurements are only susceptible of comparison with approximate accuracy: and where these elements are unknown, no comparison of sufficient value to affect vital or important interests, is possible.

5. Hence, measurements made with the best modern objectives and apparatus, and with powers of 1000 and upwards are not susceptible of accurate comparison with the older measurements of the same objects, even where powers approaching or exceeding 1000 were used for the old measurements.

6. Therefore, with special reference to blood-corpuscles, the conclusion is, that until an identical standard of measurement is used by all observers, measurements of blood corpuscles made for the comparison of different kinds of blood, should not be stated or compared in terms of any other measure, nor in comparison with other (and especially the older and more commonly published) measurements of blood, but should be stated and compared solely in terms of the micrometer used, giving also the variation, if any, of this micrometer from some generally accessible and reliable standard. By this means the sources of error will be confined to a single element, which will be constant and proportionate for all objects measured by the same observer under the same conditions, and will, therefore, afford a true comparison of the relative size of the objects so measured. And by means of the tabular variation given, any other observer can compare the measurements so made with his own or others' measurements equally as well as the observer who reports them.

Notes From Abroad.

Although the Editor, during his sojourn in London, was unable to visit many persons engaged in the manufacture of microscopical apparatus whose acquaintance he would most gladly have formed, he found time to call upon some of the most celebrated makers of microscopes, and was greatly interested in many things — so many, indeed, that only a small proportion of them can be mentioned in this article.

The first optical establishment visited was that of Messrs. Ross & Co., where we saw the various operations of lens grinding, and where we had the satisfaction of meeting Mr. F. H. Wenham, who has been the presiding genius of the microscopical department for many years.

At present Messrs. Ross & Co. are not producing many objectives for the microscope, having confined themselves mainly to improving their stands, which have reached a high degree of perfection, as our readers already know from the descriptions published from time to time in these columns. As regards the optical appliances for the microscope, however, they have not been idle. On the contrary, for months Dr. Schröder has been at work for them, calculating the curves for a series of objectives which Messrs. Ross & Co. expect will be far superior to any lenses yet seen. Whether these expectations will be fully realized remains to be seen. There are some persons in England who affect to despise the work of a great mathematician and scientific optician who presumes to produce objectives for the microscope by calculation. They may be wise in their own conceit for a time, but we can have no sympathy for them if, in the end, they find themselves left behind. Certainly the enterprise, and spirit of appreciation of strictly scientific labor, shown by Messrs. Ross & Co. in engaging the services of Dr. Schröder, in the hope of improving the microscope, as well as other optical apparatus of their manu-

facture, deserves to be cheerfully recognized by every one.

It is with no little satisfaction, therefore, that we are able to announce that already there is sufficient evidence to justify their expectations. We have seen two new objectives, a half-inch of 40° and a one-inch of 30° , in shop mountings, made according to formulas calculated by Dr. Schröder, which were so exceedingly good that we would unhesitatingly pronounce them to be the best we ever saw. This is, indeed, not the verdict of a thorough and extended trial; but we cannot resist the impression that it would be fully borne out by further examination. Both objectives were made with two systems of lenses, and a half-inch with an angular aperture of 60° with three systems, is to be made as one of the series. It is, perhaps, just to add that these objectives are not yet to be obtained, as many more calculations have to be made before the series is complete, and the manufacturers prefer not to receive orders until they are prepared to fill them.

Perhaps few microscopists visit London without making a call at the well-known establishment of Messrs. R. & J. Beck. We spent half a day very agreeably with Mr. Kemp at the manufactory, where we saw the entire process of making stands and objectives. Messrs. R. & J. Beck have, probably, the largest plant in England, and they turn out about a thousand microscopes in the course of a year. Their stands are so well known in this country, through the wide distribution of Mr. Walmsley's catalogues, that it would be superfluous to describe any of them here. It was exceedingly interesting to see the ingenious machinery used in turning out and smoothing the rough brass castings to make a beautifully finished stand. Of all the manufactories we visited, that of Messrs. R. & J. Beck was the most interesting and best arranged.

Mr. Crouch seems to be doing a large business, and he has some excel-

lent stands which are sold at very reasonable prices. It is not improbable that Mr. Crouch will, before long, appoint an agent in this country for the sale of his microscopes. His stands are all made on the same premises with his shop, the upper floor being devoted to grinding the lenses for objectives. Every stand sent from Mr. Crouch's establishment passes through his own hands for examination and approval.

We were so unfortunate as not to find Mr. Powell, of the firm Powell & Lealand, when we called upon him just previous to our departure from London, and hoped to have seen some of the latest results of his handiwork. However, we had previously met Mr. Powell several times, and the disappointment was not so great as it would otherwise have been. For fine objectives, of wide angle and high-power, Messrs. Powell & Lealand stand clearly at the head in Great Britain, and Mr. Powell, being a most excellent worker with the microscope, is one of the few persons in the trade who does not hesitate to give ocular demonstration of the excellence of his lenses.

In visiting the establishment of Messrs. Swift & Son, we were much impressed with the excellence of the microscopes made by them, and especially with the ingenuity with which they are designed. The last mentioned feature is especially noticeable in the latest form of the substage and condenser. When the original form of condenser was described by Dr. Carpenter in his book on the microscope, it seemed to us a most excellent contrivance. In its present form, as supplied to the best microscopes, we have no hesitation in expressing the belief that it is, in every respect, the most perfect, complete and convenient apparatus for illumination that has yet been devised. There is nothing else, so far as we now recollect, that comes so near our ideal of what is required for the purpose. We have often thought it strange that something of a similar kind was

not applied by other makers of stands. Now that we have seen the thing itself, we are at a still greater loss to understand the reason. Having said this much, we can scarcely do less than give a somewhat extended description of the apparatus which is illustrated in fig. 43.

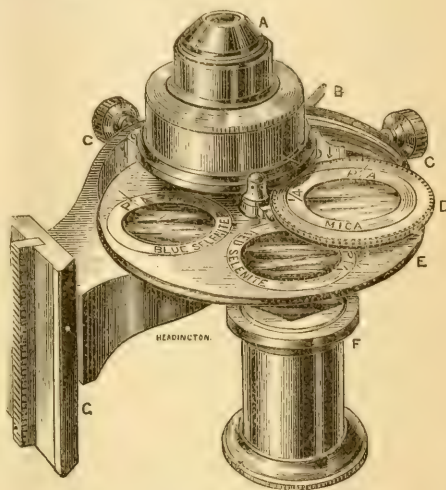


FIG. 43.—SWIFT'S ACHROMATIC CONDENSER.

Referring to the illustration, it will be seen that the condenser consists of the compact, achromatic, optical combination at *A* consisting of three lenses, the upper and middle lenses single, the lower a combination which corrects the aberrations of the others. The upper lens is fitted over the others in a sliding cap, so as to be readily taken off if desired. Mr. Swift claims that the condenser is more perfectly corrected than others of a similar kind. Our readers will doubtless remember that we have, at various times, written disparagingly of the achromatic condenser, regarding it as a very costly accessory, of no great utility for ordinary use. These remarks, however, only apply to the old forms of achromatic condensers having very small front lenses. It will be seen from the figure that in the form now under consideration the front lens is quite large, and affords an abundance of light with a large angular aperture. This form

of condenser affords an angular aperture, according to the maker's statement, of 90° or 180° , as may be desired.

Passing on to the mechanical devices, it will be seen that immediately beneath the optical part there is a thin revolving plate *E* with circular apertures, in which may be placed stops of various kinds for modifying the illumination, and films of selenite for use with the polariscope. This plate is readily turned by applying the finger at *E*, bringing the different stops successively into use. The condenser is centred by the substage-screws *C C* working against a single spring.

Immediately above the revolving plate, moving quite independently of it, are two plate holders, one of which is shown at *D*. These carry films of mica, which, when used in combination with the selenites in polarized light, give a great variety of colored effects. On the periphery of *D* are fine teeth which engage with other teeth of the corresponding plate-holder, which is not shown in the figure, being hidden from view beneath the condensing lenses. By applying the

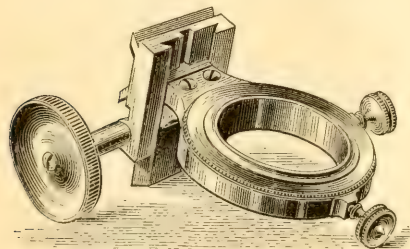


FIG. 44. — SWIFT'S MOUNTING FOR CONDENSER.

finger at *D* the outer plate is revolved and this causes the other plate to turn in the opposite direction. Either of the plates can be brought into use at will.

The polarizing prism *F* is permanently attached beneath the substage, swinging out and in on an arm, so that it can be instantly brought into use. A form of iris diaphragm is fitted beneath the condenser, adjusted by the lever shown at *B*.

A most convenient feature of this apparatus is the method of attachment beneath the stage. In fig. 43 it is represented with a rack, as it was originally made. Now, however, the condenser is fitted into a centering substage such as is shown in fig. 44, which fits into horizontal grooves in the microscope, so as to be readily removed or replaced at will. By this means the rack and pinion, substage, and condenser are all removed in one piece, leaving the entire space from stage to mirror free.

In thus according high praise to this condenser, it may be asked is it superior to that of Prof. Abbe? We would reply, it is more universal in its application, and for that reason better for the ordinary microscopist. On the other hand, it does not give so great an angle of illumination as the Abbe form, but the lenses of the latter can be used instead of the combination of Mr. Swift, without any change in the mechanical arrangements. The condenser may be readily applied to any microscope of sufficient size, but it must be specially fitted. It is rather expensive, but it answers the purpose of condenser, spot-lens or paraboloid, and polarizer, and is not, therefore, more costly than the several appliances for which it forms a substitute.

Another ingenious contrivance applied to some of Mr. Swift's stands is precisely what we have endeavored to induce our own manufacturers to adopt, but without success. It is a revolving plate of diaphragms fitted in the stage-plate. This is shown in the illustration (fig. 45), of the modification of the stand first introduced by Mr. George Wale, made by Messrs. Swift & Son, under the name of the "improved Wale's American Microscope." The milled edge of the diaphragm-plate is seen projecting from the front of the stage-plate. The device is not new, being in fact, as we are told, a very old one; but it is none the less good, and Messrs. Swift & Son apply it to several of their microscopes.

The design of the Wale stand, as applied by Mr. Swift, seems to have been suggested by the radial microscope devised by Mr. Wenham, while the plan of construction is copied from the simple and inexpensive stand of Mr. Wale, which has been so highly

the plan of which will be described in a future article.

There seems to be a great demand in England for good microscopes for physicians and students at a low price. This has led to the production of very cheap, but, at the same time good,

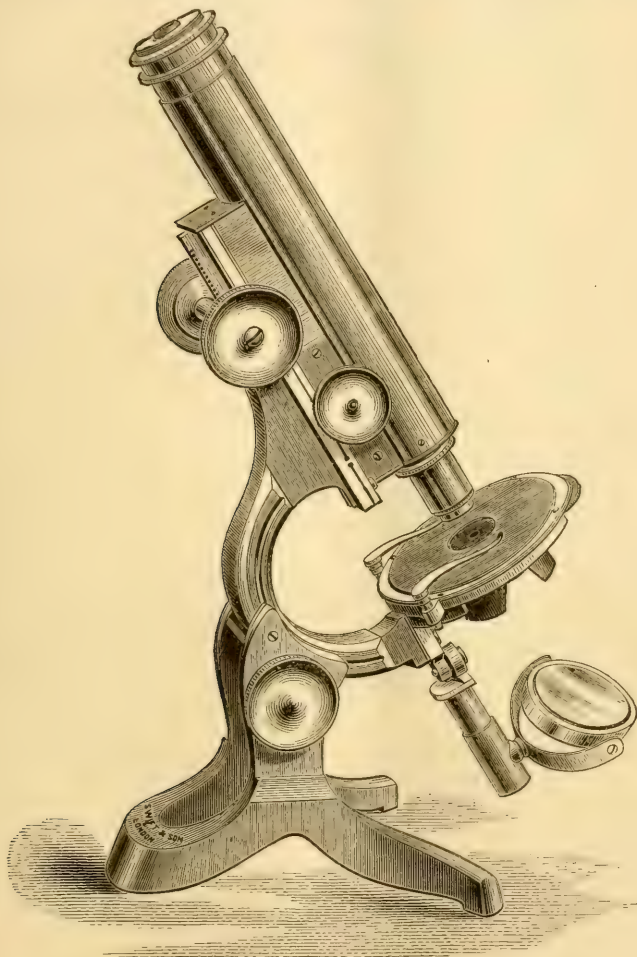


FIG. 45.—SWIFT'S WALE STAND.

commended by Dr. W. B. Carpenter, and others. At first glance it appears to be almost identical with the last mentioned instrument, but it possesses this peculiarity that the centre of curvature of the rocker is at the focal point for an object on the stage. The small milled head beneath the coarse adjustment is for the fine adjustment,

microscopes, which sell for about £6 or \$30.00, including two objectives—a one-inch and a quarter-inch. Such instruments are made by Crouch, Swift, R. & J. Beck and C. Baker, and between them there seems to be but little choice, as they are very much alike in design. They are all solid, compact and good.

A New Camera Lucida.

The camera lucida is one of the most valuable accessories the microscopist who is doing original work can have. It is true that many investigators who possess the faculty of drawing rapidly and accurately without it, disparage its use. By far the greater number, however, recognize its value, and there can be no question that drawings made, or at least outlined, by its aid, are more satisfactory to the scientific student than those made by hand and eye alone. For however accurately one may attempt to delineate an object on paper, if the outline is irregular and complex—as in some species of *Micrasteritis* for example, in which every minute indentation requires to be correctly shown in the drawing to make it useful—the eye alone is not a perfectly reliable guide. Even though the observer may be confident that his drawing is correct in all its details, it would be more satisfactory to others if made with a camera lucida. It is true that some distortion is produced by the camera lucida, but the amount is scarcely worth consideration with ordinary objects.

The Wollaston camera lucida has long been in favor, and, so far as the optical design is concerned, it is one of the very best; probably those who are accustomed to using it will not readily admit that there is anything better to be obtained. It has the disadvantage, however, of requiring the microscope to be placed horizontal, which is frequently impossible and always inconvenient, while the eye must be retained in one fixed position for drawing. The latter condition is not easily fulfilled without considerable practice, and many persons—mostly from lack of perseverance—declare themselves unable to use the instrument at all.

Many other forms, which need not be severally designated here, have been devised which can be used with the microscope vertical or inclined at an angle. Of these we have found the forms made by Mr. Grunow and Mr.

Zeiss the most satisfactory, the former having the advantage in projecting the field of view further from the base of the microscope.

The new form which we now wish to bring to the notice of our readers is not yet in the market, but soon will be placed on sale by Messrs. Ross & Co., of London. In a short time we will describe it, with the aid of an illustration, which is being prepared. As a preliminary notice we may say that we have had the opportunity of examining the first one made, which was constructed to test the formula calculated by Dr. Schröder for Messrs. Ross & Co. We can unhesitatingly declare that it is, in our opinion, the most perfect camera lucida yet devised. It can be used with the microscope inclined at an angle of 45° , or, by using an inclined support for the drawing paper at one side of the microscope, the latter may remain vertical while drawing objects in fluid. The special feature which distinguishes this camera lucida is the surprising distinctness with which the pencil can be seen in drawing—not only is the pencil-point clearly seen, but also the hand which holds the pencil, and the whole field of view is visible on the paper in a fixed position, so that the eye may be moved about without danger of losing the proper position for drawing.

Biological Analogies in Animal and Vegetable Life.

At the Annual General Meeting of the Quekett Microscopical Club, the President, Dr. M. C. Cooke, delivered the presidential address. We have prepared the following summary of the address from notes and from memory, but have not endeavored to reproduce the language of the speaker. The address will be printed in a future number of the Society's Journal.

It is no longer possible, said the speaker, to review, in the course of an annual address, the work of micro-

scopists during a year. The theme chosen was not of thrilling interest or novelty, but by making use of the work of others the speaker would endeavor to compress some matter for thought and reflection. He proposed to trace some biological analogies in the animal and vegetable kingdom.

Among some of the earliest analogies observed between the two kingdoms were those of reproduction, which was noticed in the year 1790 in *Hydra*, observed to propagate by budding. We know no more of life now than then, but much more of the phenomena of life. Life is the same in animals and plants. Turn to the first germ of either, and we find it a single cell. It is impossible to distinguish the cell that will develop into a plant from one that will become an animal. A recognition of the identity of all young in appearance, first led to the doctrine of heterogenesis.

Passing to another series of analogies, the speaker referred to the striking resemblances between some of the lower forms of life, which has led to much confusion in classification. When a single cell performs all the functions of life, it is not always possible to know to which kingdom it belongs. The proteus, or amœba, is an animal, but there is a stage in the life-history of certain fungi—the myxomycetes—in which the plant assumes the form of the proteus, and moves about as living jelly with amœboid motions. This fact has led some authors to regard the myxomycetes as of animal nature, and they have been therefore named mycetozoa. This fallacy has been insisted upon in a recent work on the infusoria. It is now known, however, that there are three stages in the life of the plant which gives rise to the amœboid form, first a condition of active movement, like a swarm-spore, then the amœboid state, and finally a resting stage. So also in the life-history of *Chlamydococcus pluvialis* there is first a flagellate stage, then an amœboid, and finally an encysted, sporiferous condi-

tion. Dr. Hicks, long ago, observed an amœboid stage in the cells of *Volvox globator*. He observed the protrusion and retraction of the plasma of some of the cells of this plant, and saw them glide along within the family of cells, and bend around some of them. So also the amœboid condition has been observed in *Stephanosphaera pluvialis*, and in *Chara*. Even a quarter of a century ago the question was raised by an eminent observer: Does amœba belong to the animal kingdom?

We have sufficient evidence that moving amœboid bodies do come from Myxomycetes, *Chlamydococcus*, *Volvox*, *Stephanosphaera*, and *Chara*. Thus we see a close and intimate relation between the phenomena of life in animals and vegetals.

Häckel, in the second volume of his "History of Creation," endeavored to establish an intermediate sub-kingdom in which he classed a great number of forms which seemed to partake of the characters of both animals and vegetals. These he named the Protista, but among them he placed many forms which are now readily distinguished as animals, such as the rhizopods, and many others now universally regarded as plants, such as the diatoms. This, the speaker said, was a poor method of getting out of a difficulty. Time and patience may reveal the relations between the two kingdoms, and it may be that the Protista will from the starting-point from which they have diverged.

Every new discovery strengthens the view of the sexuality of living forms. The zoöspores of the alga *Botrydium* unite, and the product of the union grows into a new plant. Other examples of the same kind were cited by the speaker, in illustration of this part of the subject.

Metamorphosis, as exemplified, in the butterfly, for instance, is seen in the myxogastric fungi, where we find spores and active zoöspores, an amœboid state, and finally the "imago" or perfect plant. Again

the subject may be illustrated by the changes of *Volvox*, mosses and characeæ, and in the ferns where, beginning with the asexual spores we find a prothallium develops from them which finally yields both male and female organs, from which in turn the fronds arise that produce another generation of asexual spores.

Striking analogies have been observed in the digestion of animals and plants. Plants digest the same substances as animals, in the same way. There is, therefore, a perfect definite meaning to the term as applied to plants.

Although plants have no nervous system, phenomena closely allied to the nervous sensibility of animals are frequent among them, as in the sensitive plant, in *Drosera*, and others well known; while there seems to be, in many cases, a transit of impressions from one part to another. The action of ether upon plants, their sensitiveness to light, heat, etc., was also alluded to. The cause of their movements is still unknown. If the power of movement is beneficial to a plant, it might be increased to any extent.

There seems to be a quality of instinct manifested in the vegetable kingdom. The male cells of the alga *Edogonium*, for example, swim through the water and find their way to the oögonia and enter its minute aperture to fertilize it. In other plants of the same genus, certain cells from the male filaments settle upon, or near, the oögonia, and grow into pigmy male organs in which the spermatozoids are developed, and these in turn escape and enter the oögonia. Why do they select particular cells for attachment and growth?

The speaker then referred at some length to the analogies of diseases of animals and plants, pointing out that atrophy and degeneration are observed in the vegetable world, and suggesting that there was no reason why infectious diseases of plants could not be prevented by some system of inoculation. Coincidences have been

observed in the spread of diseases among animals and plants.

Finally the speaker referred to the bearings of this subject upon the Society and its work. It justifies the union of all biologists in one society, and leads to greater sympathy between students of nature.

Cocoa and Chocolate.

In the examination of articles of food, the question frequently arises, What constitutes an adulteration? If mustard, for example, were furnished to the consumer in a perfectly pure state, without any admixture of starch or tasteless material to modify its strength, it would be quite unpalatable to most persons. Starch, therefore, is added to mustard to adapt it to the demands of consumers, and not for purposes of adulteration. Such an addition only becomes a fraud when the maker misrepresents the character of the product, or sells it at the price of a pure article. So, in many other cases, the addition of foreign ingredients to an article of food is perfectly proper and even necessary.

The manufacture of different preparations of the cocoa or cacao bean, has attained great importance during the past few years. The cacao beans possess great nutritive value, besides having a very large proportion of fatty matter—the so-called cocoa-butter—which may be readily separated in the form of a fine, white fat, which melts at a low temperature. From the cocoa beans are made two distinct preparations, known respectively as cocoa and chocolate. The broad distinction between these is that some of the fatty matter is separated from the former, while all the fat is left in the preparation of chocolate. Cocoa is, therefore, less rich than chocolate, and is regarded as much more digestible, retaining the full nutritive value of the beans without the fat.

In the preparation of cocoas,

chocolates, etc., the beans are first roasted in metallic cylinders revolving over a fire. They are then broken up, the outer covering being thus detached, and separated from the inner portion by a current of air from a blower, forming the cocoa-shells of commerce. The broken, roasted beans from which the shells have been separated constitute the cocoa nibs. From the cocoa nibs all the preparations of chocolate and cocoa are made. The nibs are first ground between heated granite rollers whereby the hard parts are disintegrated and the fat is melted, forming a thin pasty mass which flows in a dark-colored, continuous stream into a receptacle where it solidifies on cooling. To make cocoa out of this material the greater part of the fatty matter is removed by pressure, and the finely powdered residue is pure cocoa.

Many cocoas found in the market contain more or less starch, which is added, it is asserted, to make them more soluble in hot water. Starch is not a necessary ingredient of cocoa. On the contrary, the finest cocoa is made entirely without starch. This is true, for example, of the "Extract of Cocoa" manufactured in England by the Messrs. Cadbury Brothers.

Chocolate, which contains, or should contain, all of the fatty matter, unless it is distinctly stated on the label that a certain portion has been removed, requires the addition of a certain proportion of starch in the process of manufacture.

A preparation of pure cocoa with starch and sugar is sold by a few manufacturers under the name of chocolate in powder, or chocolate powder. This mixture contains no flavoring extracts, and thereby differs from what is ordinarily known as chocolate.

The addition of starch, in the preparation of chocolate, is not an adulteration, since it is necessary. The question to be decided by the microscopist in examining chocolate would

be, whether an unnecessary or excessive quantity of starch is present; for in such a case the specimen should be condemned as adulterated.

The purpose of this article is to suggest, for the convenience of microscopists and food-analysts, a distinction between the products of the cocoa-bean, by defining the words cocoa and chocolate. It is not presumed that the trade-names of the different preparations will be changed to conform to any proposed nomenclature, but since the trade-names convey no definite information of the composition of the articles, a definite nomenclature is necessary for scientific purposes. We would propose the following distinction between cocoa and chocolate: Cocoa is a preparation of the cocoa bean from which the fatty matter has been in great part extracted, and to which no starch or flavoring has been added. In other words, it is the pure cocoa without the fat. Chocolate, according to the proposed nomenclature, contains all, or a considerable part of, the fatty matter of the bean.

With this broad distinction there would be few cocoas and many chocolates found in the market; and a further subdivision would require to be made among the latter, classing the now so-called cocoas, which have some of the fat removed and only starch added, as plain chocolates, while the richer, flavored chocolates might be designated as flavored chocolates. The advantage of these distinctions would soon become apparent to the food-analyst, and also to the general public, for, although it is impossible to make a perfectly satisfactory distinction such as above suggested, the names would convey certain information as to the nature of the products so designated. At the present time one cannot tell from the names what preparations of cocoa he buys. "Cocoa" means anything that is not chocolate—that is, any preparation made from cocoa-beans that is less rich in fatty matter than

chocolate, and not flavored. It may be a really good preparation, well worth its price, or a very inferior article owing to the quantity of starch it contains. If we once understand that cocoa can be prepared without starch the microscopist will be able to select the pure specimens at a glance. As regards the chocolates the task is not so easy, but experience will lead to useful results by microscopical examinations far more quickly than by chemical analysis. The true value of a chocolate will depend not absolutely upon the proportion of starch and pure cocoa which it contains, but also upon the amount of fatty matter. The fatty matter of the bean necessitates the addition of starch in the preparation of chocolate, but the addition of more starch than the quantity of fat present in any preparation requires, constitutes an adulteration.

New Slides of Diatoms.

[Mr. C. L. Peticolas has sent us the following communication relating to some very beautiful slides he has recently prepared. — Ed.]

Slide No. 1. — *Stauroneis acuta*. Microscopists are familiar with the beautiful effects of dark-field illumination upon certain diatoms. Some peculiarities of structure are shown by this method more clearly than by transmitted light. A recent gathering of *St. acuta-Pleurostaurum acutum*, Grunow, has given me a sensation, although I have practiced this method of illumination for years. With a $\frac{1}{2}$ -inch objective and strong artificial light on dark-field, this diatom seems literally to blaze, and surpasses in splendor the finest polariscope objects in my cabinet. With the light thrown across the short diameter, there is strong resemblance to a section of ostrich tendon, only some peculiarity of striation seems to impart motion to the light, and the diatom seems on fire; across the long diameter the color is changed to a brilliant sapphire.

Slide No. 2 contains a recent gathering from Fernandina, Fla., which gives the best showing of the beautiful marine diatoms of that coast, I have yet seen. I have noted the following forms, among others, and as there is quite a number not yet identified, and the forms are shown generally in perfection, it will be seen that this is an exceedingly interesting deposit: —

Eupodiscus argus, radiatus; *Triceratium favius, punctatum, spinosum*, (rare); *Navicula lyra* (several varieties), *Formosa*; *Pleurosigma Balticum, angulatum* (rare); *delicatulum* (rare); *Actinocyclus*, Ehr.; *Biddulphia rhombus, pulchella*, and other species; *Terpsinoe musica, Americana*; *Amphiprora elegans, pulchra* (rare); *Coscinodiscus excentricus, radiatus* (?); *Surirella* three species; *Raphoneis rhombus*; *Fragillaria Schwarzii* (rare); *Stauroneis aspera*; *Nitzschia* five species; *Orthosira marina*; *Triceratium*, three species; *Actinocyclus undulatus, splendens*; *Auliscus sculptus, pruinosus*; *Biddulphia rhombus, tuomeii*; *Cocconeis Pacifica*; *Campylodiscus echineis, imperialis*; *Podosira maculata*; *Scoliopteleura turmida, late striata*.

A New Mounting Fluid.

G. W. MOREHOUSE.

For preserving the cell-contents and the natural color and form of desmids, volvox, and other algæ, I find a mounting fluid made as follows to act well: Dissolve 15 grains of acetate of copper in a mixture of 4 fluid ounces of camphor water, 4 fluid ounces of distilled water, and 20 minims of glacial acetic acid; add 8 fluid ounces of Price's glycerin, and filter.

When sections of plant-stems, or other vegetable specimens, are mounted in this fluid, the protoplasm is preserved. If, in any case, it is thought desirable to increase or diminish the specific gravity of the preservative, the proportion of glyce-

rin may be changed. Used as above, or modified as indicated, I think it also a trustworthy medium for mounting infusoria and the softer animal tissues.

EDITORIAL.

CONTRIBUTIONS, exchanges, and letters should be addressed to the Editor, P. O. Box 630, Washington, D. C.

SUBSCRIPTION-PRICE, \$1.00 per year, in advance. All Subscriptions begin with the January number.

AFTER April 1st, 1884, the subscription price will be \$1.50

TO SUBSCRIBERS.—The following notice has been sent to us for publication, by Messrs. Cassino & Co.;—"The publishers regret that their advertisement-circular in the last issue should have caused any one to suppose the JOURNAL would be discontinued after this year. It was not the intention to mislead any one, but to notify subscribers that we should no longer be the publishers."

S. E. CASSINO & CO.

CHANGE OF MANAGEMENT.—One year ago the Editor believed that if the JOURNAL were placed in the hands of a publisher of books and periodicals, it would be a benefit to subscribers and advertisers as well as to himself. He expected that publishers would not only be able to give it a far wider circulation by the systematic distribution of specimen copies, but that the cost of publishing would be materially reduced, and the profits correspondingly increased, while at the same time the Editor would be relieved of many details of a purely business character. These expectations have not been fully realized; and the Editor is very well pleased that he can once more resume his former position as publisher. This change of man-

agement has already been announced by a circular sent to subscribers, stating that the JOURNAL would hereafter be published in Washington, D. C.; where the editor will hereafter reside, having taken a position in the National Museum.

A series of articles for publication next year, which will add greatly to the interest and practical value of the JOURNAL is already in course of preparation. The first article will appear next month when the series will be more fully announced, and the titles given so far as known.

The January number will be issued at the usual time, and will be sent to all present subscribers. Future numbers will only be sent to paid subscribers, except as specimen-copies. The JOURNAL being now well established, it is considered time to adopt this rule. The time and trouble required to keep numerous running accounts of \$1.00 each, rendering bills from time to time, and the uncertainty of collecting some of them at all, are sufficient reason for this course. When the JOURNAL only existed in the expectations and intentions of its promotor, it was necessary to give credit, and a hundred or more persons took advantage of it for three years,—and some for a longer period not yet brought to a close. It was only a dollar each to them but \$100.00 to us. We are no longer in that position. The JOURNAL is established. It pays its way, and a trifle more. Those who desire to receive it are requested to favor us with the subscription-price in advance, precisely as they would for other periodicals.

At no time in the history of the JOURNAL have there been such indications of wide-spread interest in microscopical work, as there are now, if we may judge from the activity of which we hear from various directions, and from the quantity of matter already in hand awaiting publication.

Subscribers will observe that the subscription-price remains the same up to April 1st, after which it will be increased.

DEATH OF ROBERT B. TOLLES.—Mr. R. B. Tolles, one of the best known makers of microscopes and objectives the world has ever known, died on Saturday, the 17th of November. We defer an extended notice of his life and accomplishments for a future article, the time for its preparation being too short for this month's JOURNAL. Mr. Tolles leaves a wide circle of friends, for he stood very high in the opinions of all who knew him.

UNITY OF PLANT-STRUCTURE.—

The simplest microscopic plants perform all the functions of plant-life as perfectly as do the more complex members of the vegetable kingdom. Through all the differentiations of tissues which have taken place in the development of the higher plants from the simple cells—changes which have resulted, for example, in the adaptation of special cells to certain functions, such as assimilation and digestion of food, respiration, circulation, etc.,—there has been maintained a perfect interdependence and unity of action, which has been especially recognized by Strasburger, who has treated the subject in an able manner. Perhaps the most striking of all manifestations of the intimate relations between the different parts of a plant, are seen in the movements of the so-called sensitive plants, in which an irritation of any part is transferred, in some unknown manner, along the stems and branches to other parts.

Recent researches with the microscope have indicated that the impulses are conveyed through the protoplasm of the cells, which, in some cases at least, is continuous from cell to cell. The fact that in the sensitive plant the protoplasm of the cells is affected by irritation has long been known; but how the irritation, or the protoplasmic change produced by it, is conveyed from cell to cell has not been understood. One method of investigation which has led to the discovery above mentioned is, in brief, as follows:

Very thin radial and tangential sections of the cortical tissue of the young stems of laburnum, the buds of the sycamore, and of the stems and base of the leaves of other plants were prepared, the best results being from specimens obtained in January. The sections were then treated with dilute, and then from 20 to 48 hours with concentrated sulphuric acid. After careful washing with water, the sections were prepared for examination with glycerin. All these operations were performed with the specimen on the slide. The whole of the cell-wall is thus removed and often the intercellular substance also. In this way it was found, by Mr. Hillhouse, that the so-called pitted cells communicate with each other by openings through which protoplasmic threads extend; but these threads can only be detected after removal of the cell-walls, as in the manner above described, being too delicate to be observed *in situ*. After the cell-walls are destroyed the connecting filaments may be seen. These researches, which are confirmatory of those of other observers, indicate how the impulses which cause the movements of *Mimosa*, for example, are conveyed along the cells, and it would be well worth the labor of microscopists during the winter months,—even for amateurs who are too often loth to undertake observations of a delicate nature—to prepare specimens illustrative of the interesting facts thus discovered. Such preparations would have more than a special interest to the microscopist, for no botanist or physiologist would pass them by without a careful examination.

THE ARMY MEDICAL MUSEUM.—

Probably the most complete and well-chosen collection of apparatus for microscopic work in the country is at the Army Medical Museum at Washington, brought together by Dr. J. J. Woodward, and used by him in his investigations. That apparatus has been lying idle for a long time, owing

to the serious illness of Dr. Woodward, who, we regret to learn, is not likely to be able to resume his post at the Museum. Among the army surgeons there are not many fitted, either by experience or inclination, to make proper use of the valuable apparatus in the Museum, and a rumor has come to us that a Curator is soon to be appointed, who will have the apparatus in charge. This is a matter in which all microscopists are interested, for we are accustomed to look to the Museum for some of the best histological microscopical work, and also for the finest photographic work with the microscope that has yet been seen.

In the hope that the work so admirably begun by Dr. Woodward may be continued in a manner creditable to the institution, and to the medical profession represented in the army service, we trust the appointment to be made will be carefully considered by the new Surgeon General.

There is one gentleman, well known to the readers of this JOURNAL for his painstaking original work with the microscope, who would fill the position with ability and credit. It is scarcely necessary to mention the name of Dr. G. M. Sternberg in this connection. Eminently qualified for the position, an industrious worker in an uninviting, but one of the most important, fields of microscopical research, and practically familiar with all the apparatus used in photographing microscopic objects, we are assured that every microscopist would be pleased to learn of Dr. Sternberg's appointment to the position of Curator in the Army Medical Museum.

FIXING INFUSORIA.—Mr. Saville Kent states that a solution of iodine acts upon infusoria in almost the same manner as osmic acid. His solution is prepared by making a saturated solution of potassic iodide in water, in which is dissolved as much iodine as it will take up. The solution is then diluted to a brown sherry

color. In making this solution for personal use it is well not to use very much of the solution of potassic iodide, as it will require a considerable quantity of iodine to saturate it—a drachm or so of water will make a sufficient quantity for a long time.

Another agent has been used for fixing the soft animals of the tintinnodæ in their natural position. This was successfully used by Dr. Fol, who found it more satisfactory than osmic acid, acetic acid, chromic acid or picrosulphuric acid. The reagent used was perchloride of iron. The method of preparing the solution we cannot give, but the reagent is easily obtained from a pharmacist, and it would seem worth while for some amateur microscopist to make experiments with it, to determine if it is capable of general application. After the animals were killed they were washed with alcohol and treated with gallic acid, which produced a brown coloration, especially of the nuclei.

Readers of the JOURNAL would, we are sure, be glad to learn the results of experiments made with this agent for killing infusoria, and minute forms of life generally.

THE SEXUAL CHARACTERS OF AMERICAN AND FOREIGN OYSTERS.—Mr. J. A. Ryder, whose success in the artificial cultivation of oysters has already been noticed in these columns, has published an article on the sexual characters of the oysters of America and Europe, in which he states, contrary to previous belief, that the sexes of the European oyster are not separate, as in the American species. The investigation leading to this conclusion may be briefly summed up as follows: The oyster *Ostrea edulis*, is removed from the shell and hardened by the action of a two per cent. solution of chromic acid, which is allowed to act several days, after which the acid is removed by washing in water, and the specimen transferred to alcohol. Thick blocks are then cut, transversely, and

these, after soaking in water for a day, are dried, placed in a strong solution of gum arabic, and finally treated again with alcohol. Sections are then cut with a microtome, and stained with a mixture of equal parts of a strong solution of safranin and methyl green in alcohol, diluted with eight parts of water. The safranin stains the eggs, while the methyl green goes to the spermatozoa and the spermatid cells.

The species above mentioned, *Ostrea edulis*, is hermaphrodite. *O. Virginica* and *O. angulata*, on the other hand, are unisexual. It appears, therefore, that at least one species of oyster is capable of self-fertilization; yet there is no reason to suppose, as might be inferred, that the generative organs alternately produce male and female elements, thus making provision against continuous interbreeding, which is not a usual course of nature, and is supposed to lead to the deterioration, and even extinction, of species. These observations of Mr. Ryder are of great interest, and are well worthy of repetition for confirmation by microscopists who can obtain the oysters in a suitable condition for experiment.

A SIMPLE REVOLVING TABLE.—Dr. Matthews described a very simple and inexpensive form of revolving table for microscopical use, at a recent meeting of the Quekett Club. It differs from all other revolving tables in that it is used on top of an ordinary table. It consists of two perfectly flat, wooden boards, placed face to face, the upper one turning on a pivot in the centre of the lower. The lower board should have some rubber on its under surface, or some material which will cause it to remain in position on a table while the upper one is caused to revolve. Without further description we doubt not some of our readers will be tempted to make such an arrangement for carrying microscope and lamp, and others would doubtless be glad to know from them how well it satisfies the requirements of a revolving table.

MEASUREMENTS OF BLOOD-CORPUSCLES.—The author of the valuable contribution treating of this subject, which is published on another page, has brought out some facts that are well worthy of consideration. For the most part they must have occurred to every careful investigator in this important field of research. All observers, however, are not careful, and many are even careless. It is well, therefore, that the sources of error should be set forth; and we trust the article will prove a serious obstacle to those who, with undue assurance, venture to recognize human blood.

If, as the author states, it be found that the average size of human blood-corpuscles is $\frac{1}{3400}$ instead of $\frac{1}{3200}$ of an inch, it needs no words to point out how uncertain are the assumptions upon which "expert testimony" has been founded—upon which human life has been jeopardized and even sacrificed.

Fortunately, thanks to the clear heads in the legal fraternity, it seldom happens that erroneous scientific testimony carries great weight in important trials; and to this fact, rather than to the credit of the expert, the prisoner at the bar owes his protection against undeserved punishment or conviction. On the other hand, prosecutors or defendants in suits at law requiring the services of microscopists would do well, if they desire justice, to employ experts of reputation and recognized integrity, rather than those who, for a trifling fee, manufacture evidence to suit either side at will.

In passing, however, it may be reasonably asked whether it is true, as might be inferred from the author's words, that the objectives and apparatus used in the past—say thirty years ago—were so imperfect that trustworthy results could not be obtained by them. We may freely grant that, perhaps, the micrometers used at that time were not correct. This, however, affects only the absolute dimensions obtained, and does not in anywise invalidate the relative sizes of

the different objects measured. Hence the important question hinges, not upon the absolute accuracy of the divisions of the micrometer, but upon the quality of the objectives.

Perhaps we of the present time are inclined to over-estimate the advantages of our best objectives for the particular work now under consideration. If we are endeavoring to establish absolute sizes, it is important that the sharpest definition of the disks should be obtained; but for relative sizes it is not so essential, as anyone can understand. The point we desire to make in this article is, that the work of Gulliver and some others of his time, possesses a value even to-day; for while their unit of measurement may have been erroneous, and their objectives inferior, the results are probably as correct — that is to say, as comparable among themselves — as those that can be obtained now, with the same magnifying powers.

The author also refers to the difference in measurements made by two observers under the same conditions. It would be interesting to determine just how much this difference is, for blood-cells. It will probably be found very insignificant between practiced observers. The five per cent. is clearly an extraordinary variation. It will be remembered that Profs. Rogers and Morley experimented to determine the limits of accuracy in measurements of ruled lines, working independently, and their results were practically identical. But the variation would undoubtedly be greater in the case of blood-disks.

The whole article points to the necessity of adopting a standard micrometer, which we have repeatedly urged upon microscopists, and we trust it will not be long before the standard is fixed, and deposited where it can be used for purposes of comparison.

Our readers will, we doubt not, look forward with much interest to the article promised by Mr. Vorce, for a future number of the JOURNAL.

NOTES.

— It is often necessary to employ macerating fluids in the study of microscopic structures, and in the study of coelenterata the following solution for the purpose has been used by O. and R. Hertweg, with good success. It consists of acetic acid 1 part, osmic acid $\frac{1}{2}$ part, sea-water 1,000 parts. By maceration in this fluid, nerve-cells, mussel-cells, etc., can be isolated and their forms thus observed.

— Dr. Geo. M. Sternberg recently spoke on the subject of micrococci before the Biological Society, of Washington. In attempting to give an idea of the minuteness of some of the micrococci, he stated that a drop smaller than a pin-head might contain five hundred millions of them.

CORRESPONDENCE.

THE TONGUE OF THE BLOW FLY.

TO THE EDITOR.—In following out the directions given in the admirable article entitled "Unpressed Mounting for the Microscope," reprinted at page 229, Vol. 3 of this JOURNAL, I met with one difficulty which may also have been encountered by others. I found that while it is an easy matter to catch and decapitate your blow fly, unfortunately he will not always protrude his tongue properly during the operation, and my experience is that the tongue remains forever after fixed in the position that it happens to be when life in the fly becomes extinct. To remedy this I tried the plan of immersing the living insect in alcohol, and with perfectly satisfactory results. At the moment of death the tongue is forcibly protruded to its entire length. Even the short proboscis of the house fly is satisfactorily displayed.

I tried carbolic acid in the same way, but the results were not nearly as good, and besides alcohol is a much nicer fluid to handle.

A. L. WOODWARD.

A CORRECTION.

TO THE EDITOR.—Will you allow me to ask the attention of the readers of the November JOURNAL to the incorrect ar-

rangement of Figs. 27 *b* and 41? The former represents *Salpingoeca acuminata*, the latter *Monosiga Woodie*.

DR. A. C. STOKES.

TRENTON, N. J.

MICROSCOPICAL SOCIETIES.

We have an entertaining account of an exhibition given some time ago by the Microscopical Society organized in Chester, Pa., about 18 months ago. The Society is active and strong, as we learn from a letter from the President, Mr. Thomas Moore, and we hope to receive regular reports of its meetings in future. At the Microscopical Exhibition of the Philadelphia Academy, the Chester society was credited with the best suburban exhibit.

At the annual meeting of the BALTIMORE Microscopical Society, held Saturday evening, Oct. 20th, the following officers were elected:—President, Dr. L. M. Eastman; Vice-President, Dr. Edward Schaeffer; Secretary, Geo. L. Smith; Treasurer, F. W. McAllister; Librarian, Prof. Otto Luger. The regular meeting was held November 3d, with a full attendance. Mr. Geo. L. Smith read the paper of the evening, his subject being Spiders. After showing the relationship of the arachnida to the rest of the animal kingdom the writer gave a very intelligible description of the anatomy and physiology of spiders. In speaking of the popular dread of the bite of a spider, several authorities were cited to prove that there is no known spider whose bite is fatal, and that the demonstrations following the bite of the *Tarantula* are not the direct result of any poison, but nervous depression or ecstasy.

In his description of the spinning of the web, he spoke of the hundreds of minute openings in each spinner, each opening exuding a gluey substance forming an infinitesimal thread, and hundreds of these together forming the thread as we see it. The spider must either secrete two kinds of glue or have the power of modifying the secretion, as proved by the fact of part of the web being dry and part covered with little globules of adhesive material. The paper ended with an interesting account of the habits of different kinds of spiders and the peculiarities of different webs. The subject was made very clear by the aid of several well-drawn

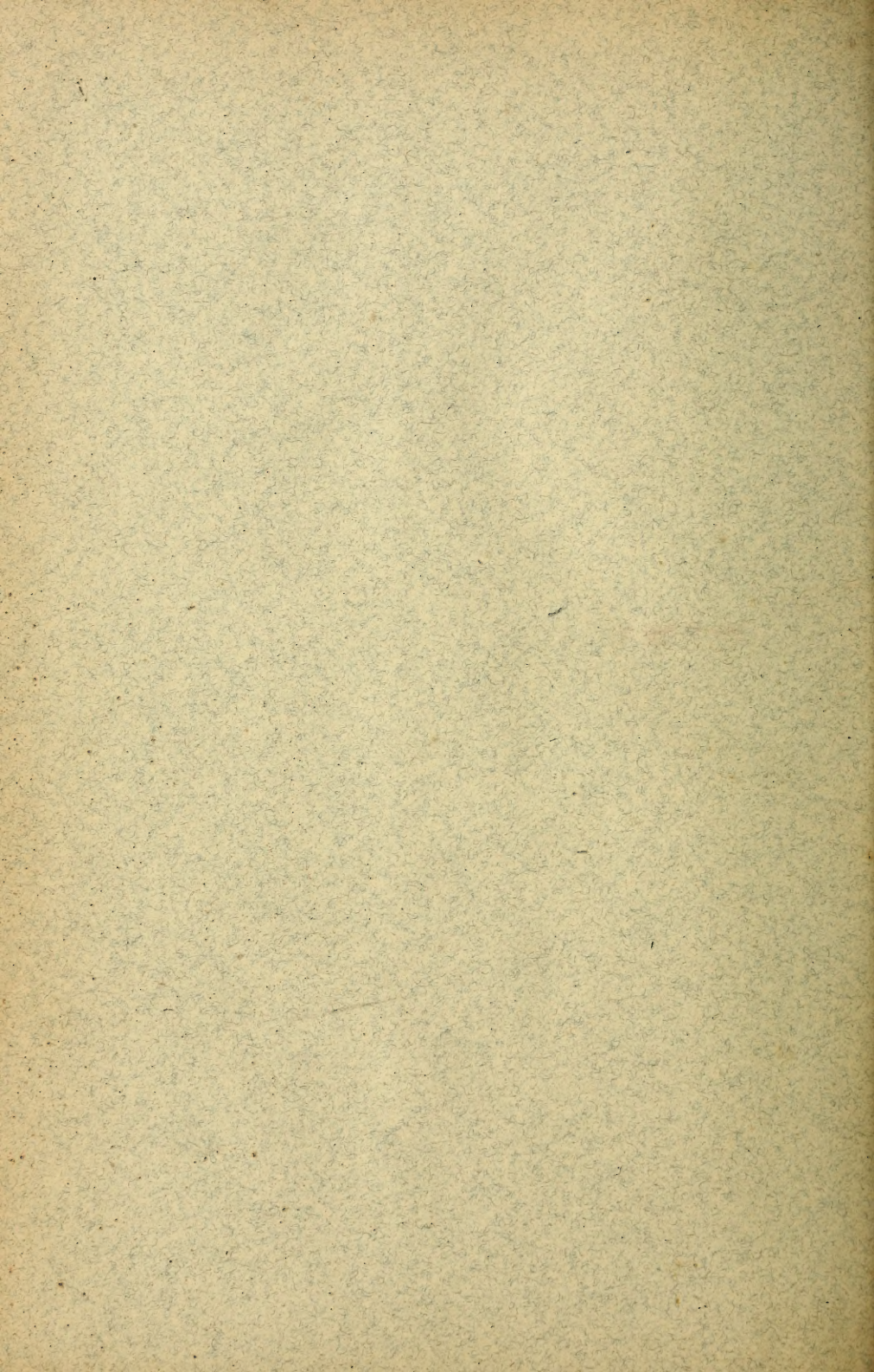
diagrams and a number of microscopical slides.

The section on mounting made a report through Mr. A. H. Ehrman, in which he described a method of making cells for both transparent and opaque objects, either dry or fluid. The material he uses is the common brass curtain-ring, which being hollow can be flattened down to make a very shallow cell. The rings are cemented to the glass, one above the other, to any desired height, by means of asphalt or cement. The top ring had better be smaller than the others as it increases the strength and improves the appearance of the cell. The asphalt is suitable for dry mounts only. For fluid mounts Mr. Ehrman found alcohol shellac to give the greatest satisfaction as a cement.

The introductory meeting of the CENTRAL NEW YORK MICROSCOPICAL CLUB, for the season of 1883-84, was held in Syracuse, N. Y., Monday evening, September 24th, A. Clifford Mercer, M.D., President, in the chair.

The Club begins its third year in a more flourishing condition than ever before. It has an active membership of forty-two, and applications for membership are constantly being received. The treasury is full, and a scientific library has been started. With an increasing membership, the requirements of such a large body of workers, seem to demand larger rooms, and the matter is being favorably considered. The Club having been granted Articles of Incorporation last May, the principal business of this meeting was the report of the Committee on Revision of the Constitution and by-laws, to meet the needs of the Club in its new capacity as an incorporate body.

It is proposed to have "Working Evenings" this season, devoting less time to general discussions and more to practical work in mounting, section cutting, staining and the manipulation of instruments, in order that every member may become perfectly familiar with the methods of practical microscopy. After general business, the Club adjourned and Mr. Geo. K. Collins exhibited to the members some very beautiful mounts, the work of Mr. Freestone, of Oswego. The slides exhibited were mounts of Volvox and seeds of plants. Mr. Freestone works with instruments of his own make, and mounts his specimens on slides of his own cutting. The slides of Volvox elicited much admiration, as the specimen had been mounted in its natural state.



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